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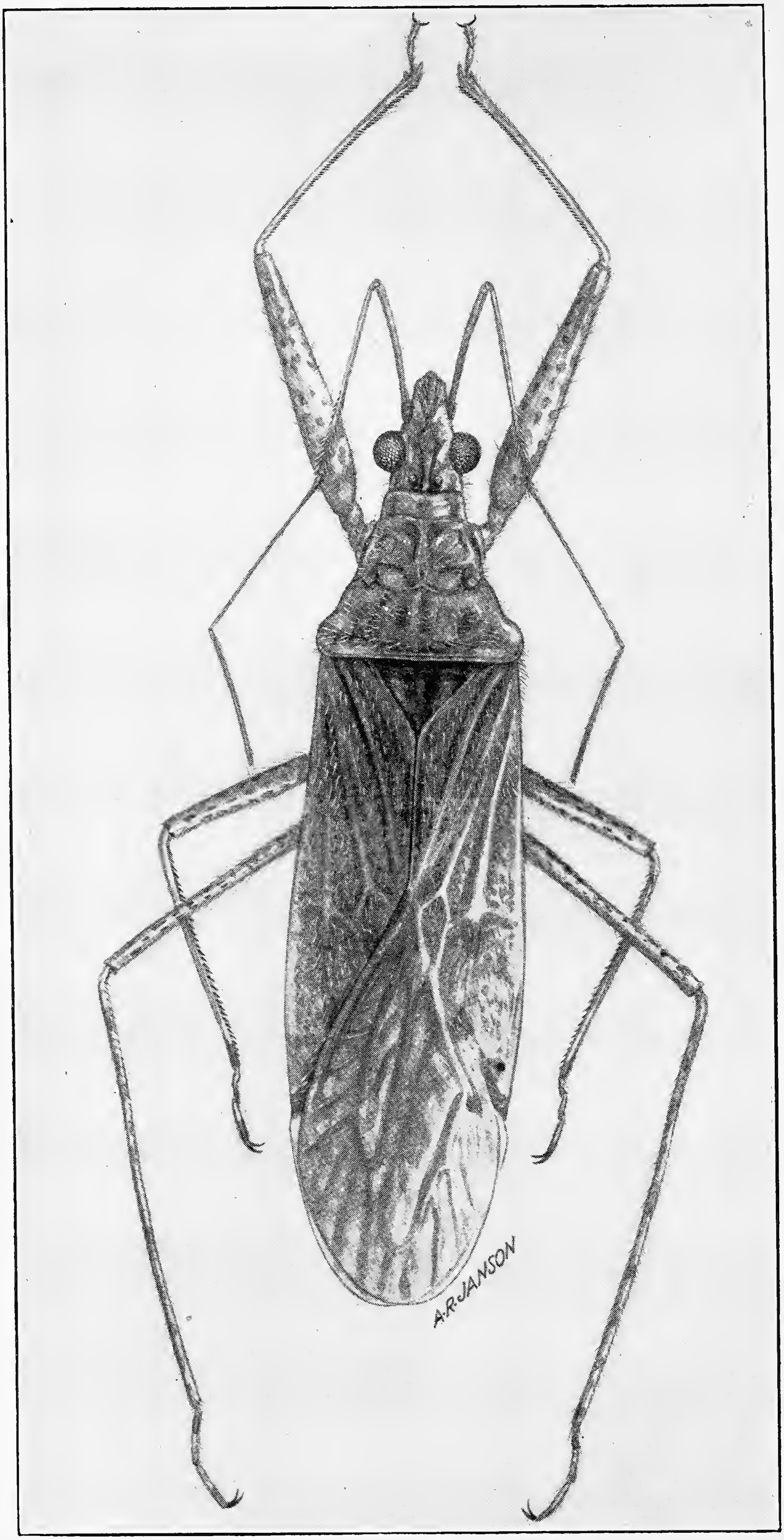

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A MONOGRAPHIC STUDY OF THE HEMIPTEROUS FAMILY NABIDAE AS IT OCCURS IN NORTH AMERICA

By Halbert M. Harris
AMES, IOWA

This paper, a summary of studies carried on by the writer during the past few years, is offered as a contribution to our knowledge of the insects of the hemipterous family Nabidae. Even though few in number of species, the family is world-wide in distribution. The American forms of the group have been described largely in the works of Stål and Reuter and unfortunately the type specimens, deposited in museums of other countries, have been unavailable to American workers. The original descriptions of the species have been printed largely in some language other than the English and have also to a great extent not been available to the average worker. These difficulties coupled with the fact that many of the species are dimorphic or even polymorphic in regard to wing development have made it extremely hard for the systematists of this country to correctly place specimens in their collections. It is the author's hope that this paper will alleviate these troubles and be of some aid to students of the Hemiptera.

The work has been made possible only through the hearty cooperation of the systematists and the curators of museums of this country. Especially does the writer owe thanks to the following

who have by the loan of specimens, by giving valuable suggestions, or otherwise helped in this study: Dr. Carl J. Drake, at whose suggestion and under whose guidance the work was undertaken, Dr. H. H. Knight, Dr. H. B. Hungerford, Dr. T. B. Frison, Dr. H. M. Parshley, Mr. W. L. McAtee, Mr. H. G. Barber, Mr. Wm. J. Gerhard, Mr. E. P. Van Duzee, Mr. W. E. China, Mr. J. R. de la Torre-Bueno, Mr. W. S. Blatchley, Prof. J. M. Watson, and Prof. R. W. Harned.

In this paper synoptic keys, with descriptions and those biological notes that are available, are given for all the species of the family known to occur in North America, including Central America and the West Indies. The descriptions have been made, wherever possible, from specimens before the author. They were made with the aid of a binocular microscope with 7.5 x ocular and 40 mm. objective, using a micrometer eyepiece upon which 24 divisions equal one millimeter. In comparing measurements of the anterior femora, as is done especially in the genus *Nabis,* the length is the distance along the lower surface from the apex of trochanter to tibia and the thickness or depth is the greatest distance from dorsal (outer) to ventral (inner) surface when the femur is studied from the side. The width of the insect is always taken at the pronotum, except where expressly stated otherwise, and the length of the pronotum is always the median measurement. The synonymy or bibliography of each species is reduced to include only the citations of most importance.

HISTORY AND PHYLOGENY OF THE NABIDAE

The family Nabidae was erected by Costa in 1852 as a division, the subfamily Nabini, of the family Reduviidae. In 1861 Fieber elevated the group to family rank, separating it from its nearer relatives by the 4-segmented beak. This opinion of the independent family rank of the group was followed by Stål, by Reuter, and by most of the recent authors, though some retained it as a subfamily of the Reduviidae. The writer considers the family to be distinct from the Reduviidae, from which its members may be differentiated by the very evidently 4-segmented beak, the absence of a striated or granulated groove on the prosternum for the reception of the tip of the beak, by the different nature of the branching of the veins of the hemelytra, the differently constructed genitalia, and the difference in the eggs and in oviposition habits.

The name *Nabidae* has recently been changed to *Nabididae* and was so used by Bergroth and others. Perhaps this resulted from Distant's use (1904) of the term as *Nabidinae.* The writer has been unable to find that any one has given reasons for the change and he feels that the name should remain as it was originally used. The name is based upon the genus *Nabis* as used first by Latreille in 1802. In the Latin literature the word *Nabis* occurs both as a common noun and as a personal noun. As a common noun it was used as the name of a giraffe, derived from *Nabun,* the genitive of which is *Nabis;* thus by adding *idae* to the stem the name would be *Nabidae.* However, if Latreille had the personal noun *Nabis* (the name of a king of Sparta; genitive, *Nabidis*) in mind the family name should be *Nabididae.*

Phylogenetically the Nabidae are considered as relatively primitive hemiptera. They are closely related to the Reduviidae, the Enicocephalidae, and the Phymatidae and with these constitute the superfamily Reduvioideae. Perhaps, as Reuter has suggested, these latter forms have descended from the nabids or from nabid-like ancestors. Certainly the nabid subfamily Pachynominae approaches the Reduviidae remarkably close, so much so in fact that the writer after having seen a specimen of *Pachynomus biguttatus* (Stål) from Bombay can scarcely free himself from the belief that it more nearly represents a true reduviid than a nabid. Its rostrum, although 4-segmented, is not more distinctly so than in the reduviid, *Aphelonotus simplus* Uhler which formerly was considered as a nabid. Likewise the pronotum, the antennae, and the legs are formed as in *Aphelonotus* and the author feels that future study may prove these genera to be closely related ones. On the other hand a comparison of the Nabid genus *Pagasa* Stål with the Anthocorid genus *Piezostethus* Duf. discloses so great a similarity that one wonders if they have not a closer relationship than is indicated by their present position in different superfamilies.

THE ECONOMIC IMPORTANCE OF THE NABIDAE

The Nabids so far as known are without exception of a predacious nature. Although the family is small in size (approximately 200 species are known) it ranges throughout the world and the members often occur in rather large numbers. They are small to medium in size and are commonly found in and around vegetation, where they wander about in search of prey. Their food consists largely of aphids, leaf-hoppers, plant-bugs, and small caterpillars, but when pressed by hunger they will not hesitate to attack forms much larger than themselves. Many instances have been recorded of nabids feeding upon such important crop pests as the Chinch Bug (*Blissus leucopterus* Say), the Hessian Fly (*Mayetiola destructor* Say), the Corn Ear Worm (*Chloridea obsoleta* Fabr.), and others. Osborn (1912) considers the group to be of great importance as enemies of the common leaf-hoppers affecting grasses. The writer has observed members of the family feeding upon many different species of aphids, leaf-hoppers, plant-bugs, and caterpillars, and on one occasion he found a specimen of *N. roseipennis* Reuter (Plate I) with its beak inserted in the body of a female canker-worm moth from which it was extracting the body juices. It is his opinion, however, that the group, due to their rather non-specialized feeding habits, can never be considered of especial importance in the control of any one pest. Their greatest value arises in their rôle as checks against the grass and shrub infesting insects in general. The fact that the nabids insert their eggs in the stems of plants has led some to believe that they may at times offset their beneficial qualities by thus injuring the plants. It is doubtful, however, that there is ever sufficient oviposition to seriously injure a plant. Perhaps an equally unimportant factor from an economic standpoint is that some species frequently inflict painful bites when they are improperly handled.

BIOLOGY OF THE NABIDAE IN GENERAL

Habitat

The nabids are to be found in varied situations depending upon the species. All are terrestrial. Some are ground-dwellers and are to be found running about on the ground or hidden beneath objects on the ground. The majority of our species, however, are plant inhabiting forms and they slowly wander about over low foliage in search of prey. Some prefer higher plants and are to be had only by beating trees. Many species inhabit only shady situations where the vegetation is rank, others prefer moist places where the sedges and reeds abound, while still others are lovers of the sun and are to be found in the open fields and meadows. The members of one genus (*Arachnocoris*) so far as known are inhabitants of webs of spiders, where they live suspended from the underside of the webs and apparently prey upon other insects that may be caught there. The nymphs of a few species are myrmecophilous and are to be found running about in company with certain ants to which they bear a remarkably close resemblance.

Life Habits

The adults and nymphs spend the greater part of their time in feeding or in seeking food. Some are active in the search, others prefer to lie in wait or to slowly stalk their prey. Almost invariably a struggling captive is fiercely grasped between the apposed surfaces of the fore femora and tibiae while the beak is inserted in some point upon its body, usually the base of the head. In most cases a captive ceases to struggle in a moment after the suctorial stylets have pierced its body—perhaps due to the injection of some toxic substance. Occasionally a nabid, particularly if recently fed, will show fright and run from prospective prey. The nymphs of some of the species have the protective habit, when disturbed during their wandering over the herbage, of folding their legs and dropping to the ground.

In mating, as observed in the genus *Nabis,* the male mounts the female from the rear, grasping her with the fore and hind legs and almost invariably prodding her about the head with his beak. Usually a fierce struggle ensues, the female using her beak in an effort to dislodge the unwelcome suitor. The male bends the abdomen downward around either side so that one clasper may be hooked within the valves of the female genital segments. The clasper apparently serves two functions—for holding the genital segments of the two in apposition, *i.e.,* as a clasping structure, and as a means of directing the oedagus. Copulation lasts often for a half hour and apparently occurs as often as the male is successful in his attacks upon the female. As a prelude to the mating the males of several species of the genus *Nabis* (and perhaps all of them) spend a considerable portion of their time in what is apparently a form of stridulation. A specimen climbs to some point of vantage upon the foliage and resting there proceeds to bend the abdomen slightly to one side and then rapidly beat it with the hind tibia of that side. The process halts at short intervals and then is continued. The writer has observed this occurrence in the males of *N. sordidus, N. annulatus, N. ferus, N. subcoleoptratus,* and *N. roseipennis* and although there is no sound perceptible to his ear he feels confident that the process must constitute a form of stridulation for the attraction of the sexes. This is evidenced by the fact that males kept in captivity away from females will often spend hours at the process, only stopping at short intervals. When such an individual becomes aware of the presence of a female introduced into his cage he slowly advances toward her, stops at times to make a few strokes with the tibia on the genital segment, then when sufficiently close suddenly makes a rush to catch her. The active part of the stridulatory apparatus seems without question to be the rather stiff setae on the inside of the hind tibiae. The passive part remains yet to be discovered. Although the writer has observed stridulating individuals under a lens he has yet to decide if the tibial spines are rasped against the clasper, the sides of the genital segment, or even perhaps against the very definite row or comb of setae that surmounts the apex of the last genital segment.

The eggs are placed within the stems of plants. They are cylindrical and slightly curved in outline and possess a reticulate cap that seems to be characteristic in shape for each species. The cap is the only visible portion when an egg is in place. It fits in and over the end of the egg in much the same way as a cork in a vial and when the egg hatches is simply pushed outward where it hangs suspended by a slender thread. The length of the different life-stages varies with the species. Five moults occur in all species whose life history is completely known. All species have heretofore been thought to pass the winter in the adult stage; the author however has proved that one at least, *N. subcoleoptratus* Kirby, lives through the winter in the vicinity of Ames in the egg stage.

Polymorphism

Many species of nabids exhibit pterygomorphism. In some there is a true long-winged form and a true short-winged form, while in others only the long-winged form is known to occur. At least one species has many different forms in regard to wing development, there being apparently all gradations between a true brachypterism and true macropterism. In some of our more common species the long-winged form is extremely rare and when it does occur it apparently is associated with the female sex. What the determining factors in wing development are remains yet to be discovered. The fact that in some species examples from more southern localities have better developed wings than those from more northern localities indicates that temperature may play an important part in wing development.

Accompanying the development or non-development of wings there is in all species a corresponding variation in the development of the thorax and thus in the body form. In many species there is even strong variation in such other important taxonomic characters as size of eyes and ocelli, lengths of antennal segments, degree of incrassateness of the fore femora, and shape of scutellum. Then there is in many species, especially in *Nabis*, often much variation in color development. This likewise apparently is dependent largely on temperature. For example in *N. annulatus* and *N. sordidus* specimens collected by the author at Ames, Iowa, in a low, moist, cool situation have invariably possessed darker markings than have specimens from Florida and other southern localities. In the latter individuals the darker markings are replaced by much lighter ones or often by crimson ones. The writer presumes that the crimson markings are present in the Iowa specimens but that they are overshadowed by the darker pigment, which supposedly is a melanin located in the cuticula while the lighter markings are hypodermal in origin.

Family NABIDAE (Costa)

1852. *Nabini* Costa, Cimic. Neap., Cent. III, p. 66.
1858. *Nabides* Stål, Öf. Vet. Akad. Förh., XV, p. 247.
1861. *Nabidae* Fieber, Europ. Hemip., pp. 25, 43.
1865. *Nabida* Stål, Hemip. Afr., III, p. 37.
1872. *Nabidae* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 68.
1873. *Nabidae* Stål, Enum. Hemip., III, p. 106.
1908. *Nabidae* Reuter, Mém. Soc. Ent. Belg., XV, p. 87.
1909. *Nabidae* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, p. 3.

Small to medium in size; antennae slender, much longer than head, 4-segmented (often with a more or less ring-like supplementary segment between I and II) or distinctly 5-segmented. Eyes large. Ocelli usually present, if absent the head is not dilated toward the apex. Rostrum free, 4-segmented, the basal segment short, usually about as broad as long. Pronotum divided transversely into two lobes exclusive of the apical collar. Prosternum without a median longitudinal stridulatory groove. Hemelytra coriaceous, when fully developed with clavus, corium, membrane, and sometimes embolium; the membrane with two or three longitudinal cells which rarely are unclosed. Anterior legs raptorial. Tarsi usually triarticulate (uniarticulate in *Carthasis*), the claws apical; aroliae absent. Posterior coxae rotatorial. Male genital segment symmetrical.

The family was divided by Stål into three subfamilies, only two of which are known to occur in the Americas.

Key to Subfamilies

Pronotum with the apical collar absent or extremely narrow; rostrum stout; legs short and thick; clavus not or scarcely widened posteriorly; antennae often 5-segmented. *PROSTEMMINAE,* p. 8

Pronotum with the apical collar wide and distinct; rostrum more slender; legs longer and more slender; clavus widened posteriorly; antennae always only 4-segmented.................*NABINAE,* p. 26

Subfamily *PROSTEMMINAE* (Reuter)

1873. *Nabina* Stål, Enum. Hemip., III, pp. 106, 107.
1890. *Prostemmina* Reuter, Revue d'Ent., IX, p. 289.
1904. *Prostemmaria* Distant, Fauna Br. Ind., Rhyn., II, p. 391.
1909. *Nabina* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, pp. 3, 7.

Body oblong to sub-elongate, convex from beneath. Head immersed to (or almost to) the eyes. Ocelli distinct. Eyes prominent. Antennae 4-segmented, with a ring-like supplementary segment at the base of II, or distinctly 5-segmented. Rostrum of medium length, moderately stout, the third segment extending beyond the base of the head. Pronotum sub-transverse, more or less constricted or impressed at or behind the middle; the apical collar very narrow or entirely lacking; the sides not or at most only obsoletely margined; the base feebly emarginate. Scutellum moderately large. Hemelytra with embolium distinct; the clavus not or only scarcely widened posteriorly. Metapleuron with the ostiolar orifice well developed. Anterior acetabula strongly approaching the front margin of the prothorax. All coxae moderately elongate. Anterior legs with trochanters unarmed beneath, femora incrassate and tibiae provided with a distinct spongy lobe at the apex.

This subfamily is represented throughout the faunal regions of the world. The large genus *Prostemma* Léon Duf. is Palaearctic and Ethiopian in distribution. Of the remaining six genera only three are represented in our region.

Key to American Genera of Prostemminae

I.—Body shiny; antennae 5-segmented or with supplementary segment between I and II distinct; pronotum distinctly constricted at the sides into two lobes; basal segment of venter unkeeled II

Body opaque; antennae 4-segmented, with the supplementary segment absent or obsolete; pronotum only feebly constricted at the sides; basal segment of venter with a median longitudinal keel .... *Phorticus*, p. 9

II.—Antennae with the supplementary segment much less than one-half as long as I; anterior and intermediate femora angularly widened to about the middle and armed there with a stout tooth; the part beyond the tooth greatly enlarged, that before the tooth not greatly enlarged, spinulose beneath .... *Alloeorrhynchus*, p. 12

Antennae with the supplementary segment about one-half as long as I, thus distinctly 5-segmented; anterior femora elongate-fusiform in shape, armed beneath with piceous teeth .... *Pagasa*, p. 20

Genus PHORTICUS Stål

1860. *Phorticus* Stål, Rio Jan. Hemip., I, p. 69.
1873. *Phorticus* Stål, Enum. Hemip., III, pp. 107, 109.
1890. *Phorticus* Reuter, Revue d'Ent., IX, p. 290.
1893. *Phorticus* Reuter, Wien. Ent. Zeit., XII, p. 317.
1904. *Phorticus* Distant, Fauna Br. Ind., Rhyn., II, p. 395.
1909. *Phorticus* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, pp. 8, 49.

Small, oblong, to oblong-ovate; smooth, opaque, pilose. Head short, somewhat conically produced before the eyes. Ocelli distinct, far apart. Antennae short, placed on the side of the head before the middle of the anteocular part, segments I and II thickened, III and IV slender, all more or less thickly clothed with long hairs; the supplementary segment very small or absent. Rostrum moderately long; segment II extending beyond base of head, subequal to III and IV conjoined. Pronotum more or less distinctly transversely impressed behind the middle, without a distinctly marked off apical collar, sometimes with a faint median longitudinal impressed line on the disc; the basal margin truncate. Scutellum equilateral, the disc bifoveate near the base. Membrane, when developed, with two to four oblong cells. Legs short; anterior femora more or less incrassate, usually armed beneath; anterior tibiae widened distally with a spongy fossa at apex. Ostiolar canal distinct. Venter laterally compressed at the base, thus with a distinct, short, median carina there; the last segment produced posteriorly on either side above so that it incloses the disc-like genital segment of the female. Type of genus, *Phorticus viduus* Stål.

Phorticus is a widely distributed genus. It reaches its highest development, apparently, in the Ethiopian and Australian realms. Of the three species heretofore known from the Americas two were described from Brazil and the other from Texas. A fourth from Panamá is described below. All the specimens of this genus that I have seen have a distinct median longitudinal carina on the meso- and meta-sternum. The prothorax is produced much farther forward dorsally than ventrally so that when seen from the side its front margin is strongly obliquely slanted backwards.

Key to Species of Phorticus

Anterior femora strongly incrassate, angularly widened beneath near the middle, and armed there with a strong tooth and denticulate from there to apex; apical margin of corium straight .... *collaris* Stål, p. 10.

Anterior femora only slightly thickened, not distinctly angularly widened beneath, the under surface minutely denticulate along distal two-thirds; apical margin of corium distinctly sinuate .... **speciosus** n. sp., p. 11.

Phorticus collaris Stål

1873. *Phorticus collaris* Stål, Enum. Hemip., III, p. 109.
1899. *Phorticus collaris* Champion, Biol. Centr. Amer., Heter., II, p. 301, Tab. XVIII, fig. 21.
1909. *Phorticus collaris* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, pp. 50, 54.

Small, oblong, thickly clothed with moderately long hairs; brownish, variegated with ochraceous. Head slightly shiny, brown, paler toward apex; longer than broad, tumid beneath. Eyes large, rather coarsely granulate. Ocelli wide apart, prominent. Antennae testaceous, segment I thick, slightly surpassing apex of head; II enlarged distally, subequal to width of head through eyes; III thinner and slightly shorter than II; I thinly and II and III thickly clothed with long hairs; the proportion of segments I : II : III = 6 : 14 : 12. Rostrum pale testaceous, extending onto mesosternum, segment II reaching to margin of pronotum, slightly longer than width of head through eyes (16 : 14); III twice as long as IV and conjoined with it slightly longer than II.

Pronotum with a large triangular spot extending from apex to middle of anterior lobe, and a smaller somewhat obsolete median spot on disc of posterior lobe ochraceous; slightly broader than long (34:29), transversely impressed behind the middle, the transverse impression bearing a row of distinct punctures; the anterior lobe with a faint median longitudinal line which ends in a fovea in front of transverse impression; basal margin almost truncate. Scutellum with sides sinuate, the basal half rather level, coarsely punctate, the apical half raised, impunctate, bearing many long hairs, the disc with a large pit on each side of median line. Hemelytra with basal halves of clavus and corium and a large spot on disc of corium ochraceous, apex of corium fuscous; veins of clavus and corium bordered with lines of punctures; membrane smoky, the veins distinct. Under surface and legs testaceous. Anterior femora strongly incrassate, armed as in key; anterior tibia strongly widened apically, serrately denticulate within, with a distinct spongy fossa at the apex. Intermediate and posterior legs short and stout, pilose, the tibiae also with a few spine-like setae on the outer surface and at the apex. Meso- and metasternum with a distinct median ridge. Venter laterally compressed at the base, the basal margins of the segments coarsely pitted. Length, 3.28 mm.; width, 1.03 mm.

Collaris was described from Brownsville, Texas. Champion has since recorded it from Mexico. The above description is made from a winged female bearing the label, Brownsville, Texas, June. Nothing is known of the habits except that it occurs on the ground.

Phorticus speciosus n. sp.

Smaller than *collaris,* the color paler, tending to a chestnut brown; the ochraceous patch on anterior lobe of pronotum larger, extending back indistinctly to transverse impression; posterior lobe without ochraceous markings; hemelytra ochraceous to about middle of clavus, then gradually blending into brownish.

Head testaceous brown, shiny, slightly broader than long, globose beneath, clothed with long hairs. Eyes prominent, granulate. Ocelli large. Segment I of antennae surpassing apex of head, slightly shorter than in *collaris* (other segments missing). Rostrum as in *collaris,* but slightly paler and slenderer. Pronotum broader than long (30:24), slightly constricted behind the middle, the transverse impression with indistinct punctures, the basal margin slightly angularly emarginate. Scutellum as in *collaris,* the punctures on base smaller and more scattered, the apex more acutely produced. Hemelytra smooth, the rows of punctures bordering the veins of clavus and corium indistinct; the basal margin of the membrane distinctly sinuate; membrane paler, the veins finer and more indistinct than in *collaris*. Anterior femora only moderately incrassate, armed before the middle with a bicuspidate tooth and minutely denticulate from there to apex. Anterior tibia widened apically, denticulate within, with a spongy fossa at the apex. Venter laterally compressed at the base, the median carina there distinct; basal margins of segments punctate. Length, 2.85 mm.; width, .92 mm.

Described from a macropterous female, *holotype,* taken at Ancon, C. Z., Panama, May 12, 1911, A. H. Jennings. Type deposited in U. S. National Museum. This pretty little species may be separated from our only other representative of the genus, *collaris* Stål, by its smaller size, paler color, with different markings, less hairy body, shorter legs, and less incrassate anterior femora. The sinuate base of the membrane gives to it an appearance which reminds one, only in a much less degree, of the hemelytra in the genus *Aphelonotus* Uhler. The head has two faint impressions between the ocelli, which also are present in *collaris*. The type specimen was taken at an arc light.

Genus ALLOEORRHYNCHUS Fieber

1861. *Alloeorhynchus* Fieber, Europ. Hemip., pp. 43, 159.
1865. *Alloeorhynchus* Stål, Hemip. Afr., III, p. 40.
1873. *Alloeorhynchus* Stål, Enum. Hemip., III, pp. 107, 109.
1904. *Alloeorhynchus* Distant, Fauna Br. Ind., Rhyn., II, p. 393.
1909. *Alloeorrhynchus* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, p. 33.

Oblong-ovate, smooth, shiny, moderately thickly clothed with long hairs. Head rather short, somewhat conically produced before the eyes, immersed in the pronotum to or almost to the eyes. Eyes large, their posterior margin sinuate, Ocelli prominent. Antennae slender, segment II slightly thickened distally, III and IV slender, all clothed with short hairs; the supplementary segment minute, much shorter than segment I. Rostrum moderately thick, extending on to mesosternum, segment II longest; III and IV conjoined about equal to II.

Pronotum about as long as broad, constricted behind the middle; without a wide, well marked off collar; the basal margin rather truncate. Scutellum dull, bifoveate on the disc. Hemelytra, when developed, reaching to apex of abdomen; the clavus and corium with rows of distinct punctures along the veins; membrane with two or three oblong discal cells. Legs moderately long, the anterior and intermediate femora dentately ampliated before the middle and armed from there to apex with minute teeth. Anterior tibiae angularly widened at the apex and provided there with a spongy fossa. Mesosternum and mesopleuron shiny. Metapleuron dull, rugulose, with a distinct orifice. (Type, *Alloeorrhynchus flavipes* Fieb.).

This genus, world wide in distribution, is represented in the Neotropical realm by six known species, two of which are described below as new to science. In all the species known to the writer there is, as in our species of *Phorticus,* a distinct median longitudinal carina on the mesosternum, this carina extending back onto the metasternum. Also there is on each side of the first segment of the venter, just behind and laterad to the posterior coxae a greatly enlarged posteriorly directed spiracle. The general shape of the canal of the metapleuron is characteristic for our species. The Oriental species *marginalis* Distant and *corallinus* Stål are said to be without the angular ampliation of anterior and intermediate femora (subgenus *Psilistus* Stål).

Key to Species of Alloeorrhynchus

1. Pronotum entirely nigro-piceous 2
   Pronotum with the anterior lobe wholly or partly testaceous or rufo-testaceous 3
2. Hemelytra nigro-piceous unicolorous throughout; length 5 mm. *vittativentris* Stål, p. 14.
   Hemelytra yellowish at base; length 3.5 mm. *armatus* Uhler, p. 15.
3. Posterior lobe of pronotum rufo-testaceous, with three large piceous spots, one on each humeral angle and one occupying middle of disc; hemelytra in greater part dull. *trimacula* (Stein), p. 16.
   Posterior lobe of pronotum not distinctly trimaculate with black; hemelytra shiny throughout 4
4. Hemelytra in greater part piceous brown, the costal margins pale; length 4.5 mm. or more 5
   Hemelytra in greater part pale yellow; length 3.5 mm. or less 6
5. Pronotum piceous brown, only the lateral margins paler; femora testaceous throughout; width of an eye equal to width of vertex .... **flavomarginatus** n. sp., p. 17.

Pronotum yellowish testaceous with a basal band piceous; intermediate and posterior femora annulate with piceous before the apex; width of an eye less than width of vertex.

nigrofasciatus n. sp., p. 17.

6. Width of an eye equal to one-half that of vertex; segments I–V of connexivum each with a fine submarginal row of recumbent, piceous spinules, the rows together forming an interrupted line along connexivum above and beneath.

delicatus n. sp., p. 18.

Width of an eye distinctly less than one-half that of vertex; sides of venter without black line of spinules.

nigrolobus Barber, p. 19.

Alloeorrhynchus vittativentris Stål.

1873. *Alloeorhynchus vittativentris* Stål, Enum. Hemip., III, p. 109.

1900. *Alloeorrhynchus vittativentris* Champion, Biol. Centr. Am., Heter., II, p. 200, Tab. XVIII, fig. 19.

1909. *Alloeorrhynchus vittativentris* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, p. 44.

"Nigro-piceus, nitidus, metapleuris subopacis, cum mesopleuris fortiter sculpturatis; capite, pronoto scutelloque pilis paucis longis erectis, hemielytris sat dense et sat breviter pilosis, pilis nonnihil retrorsum vergentibus; scutello subnitido, hemielytris totis nitidis, unicoloribus; antennis fuscotestaceis, basin versus pallescentibus; rostro, pedibus, ventre maculisque marginalibus superioribus abdominis pallide sordide flavescentibus, rostro basin versus, tibiis apice vel apicem versus infuscatis, vitta laterali ventris utrinque margineque postico segmentorum ventralium inter vittam et marginem nigricantibus; femoribus anticis pronoto paullo longioribus, modice incrassatis, inferne ante medium in dentem obtusum ampliatis, pone hunc crebre subtiliter denticulatis, femoribus intermediis inferne paullo pone medium denticulo armatis, ab eo apicem versus minute denticulatus; tibis anticis margine inferiore fuscocrenulatis, apicem versus oblique ampliatis et inferne fossa spongiosa instructis, hac circiter tertiam apicalem partem tibiae occupante; rostro articulo secundo duobus ultimus simul sumtis aeque longo; pronotum lobo antico capite cum oculis paullo latiore, lateribus subparallelis, lobo postico antico fere dimidio latiore, hemielytris abdomini aeque latis. Long. 5, lat. $1\frac{1}{2}$ mm."

This species was originally described from Bogota, Colombia. Champion records it from Volcán de Chiriquí, Panamá, and states that it is closely related to *A. armatus* Uhler. The above description is that of Reuter and Poppius (1909). These authors say in regard to Champion's figure "forte: color corii figurae eodem typi dilutior." The specimen reported by the author from Guatemala (Proc. U. S. Natl. Mus., 69, Art. 21, p. 1, 1926) is *A. armatus* Uhler.

Alloeorrhynchus armatus Uhler

1894. *Alloeorhynchus armatus* Uhler, Proc. Zool. Soc. Lond. for 1894, p. 204.

1909. *Alloeorrhynchus armatus* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, p. 41.

Elongate oblong, smooth, shiny, thinly clothed with scattered, long, fine hairs; rufo-piceous to reddish brown, the antennae, rostrum, legs, venter, and basal part of hemelytra to beyond apex of scutellum flavo-testaceous to testaceous. Head concolorous with pronotum, short, as broad as long. Eyes moderately large. Ocelli distinct. Antennae clothed with short fine hairs, segment I sub-equal in length to width of vertex with one eye; proportion of segments, I : II : III : IV = 12 : 21 : 20 : 26. Rostrum extending to middle of mesosternum, segment II scarcely one-half longer than antennal I; III and IV together about equally as long as II.

Pronotum smooth, broader than long (40 : 34); the anterior lobe twice as long as posterior lobe (median measure); the basal margin feebly emarginate. Scutellum dull, bifoveate on the disc, clothed above with numerous very long, fine, erect or semi-erect hairs. Hemelytra shiny, the inner third of clavus dull for its entire length; inner third and apex of clavus and apical third of corium and embolium and all of cuneus rufo-piceous; clavus and corium with the usual rows of deep punctures along the veins; membrane smoky. Legs pale testaceous, the posterior tibiae darkened; anterior femora with the dentate ampliation before the middle; intermediate femora only slightly incrassate, with the ampliation three-fifths from the base. Mesopleuron shiny, rugulose, concolorous with pronotum. Metapleuron opaque. Meso- and metasternum with a longitudinal keel. Venter shiny, slightly embrowned. Length, 3.59 mm.; width, 1.19 mm.

Armatus has been known only from the type locality, Grenada, West Indies. The above description is made from a winged female, collected by Barber and Schwarz, Alta V. Paz., Guatemala. It differs from Uhler's description in that the head is rufo-piceous throughout, the second antennal segment is not fully twice as long as first, the apical joints are not fuscous, the pronotum is rufo-piceous rather than deep-black, and the venter is not "margined on submargin with a piceous curved line."

Alloeorrhynchus trimacula (Stein)

1860. *Prostemma trimacula* Stein, Berl. Ent. Zeit., IV, p. 76.
1873. *Alloeorhynchus trimacula* Stål, Enum. Hemip., III, p. 109.
1900. *Alloeorrhynchus trimacula* Champion, Biol. Centr. Am., Heter., II, p. 300, Tab. XVIII, f. 20.
1909. *Alloeorrhynchus trimacula* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, p. 40.

Elongate-oblong, rather thickly clothed with moderately long semi-erect hairs. Head rufo-piceous, shiny, broader than long and distinctly broader than collar of pronotum, width of vertex slightly greater than width of an eye. Eyes prominent. Ocelli distinct. Antennae long, dark testaceous to piceous, paler distally; segment I longer than width of vertex with one eye; proportion of segments, I : II : III : IV = 20 : 37 : 35 : 40. Rostrum piceous brown, reaching upon mesosternum, segment II slightly longer than I of antennae; III about three-fourths as long as II.

Pronotum broader than long (female, 60 : 50), shiny; rufo-testaceous, the collar above, a large spot on each humeral angle (extending down on pleura) and another occupying the middle of the disc of the posterior lobe, piceous black; posterior lobe two-thirds as long as anterior lobe, the basal margin slightly reflexed and feebly sinuate. Scutellum dull brown, clothed with long semi-erect hairs, bifoveate on disc and sulcate posteriorly, the apex distinctly bifid. Hemelytra in greater part dull, concolorous with scutellum; the costal margin for its entire length shiny, flavo-testaceous to testaceous; membrane dull, smoky. Legs flavotestaceous, the anterior trochanters, the apical one-third to one-half of all femora, and the tibiae and tarsi rufo-piceous to testaceous; anterior femora with the dentate ampliation placed before the middle. Mesopleuron shiny, rugulose, concolorous with the maculae on the humeral angles of pronotum. Venter flavo-testaceous, with a broad submarginal stripe on each side (converging posteriorly) rufo-piceous. Connexivum above broadly exposed, segments two to five each with a piceous patch of short, fine, recumbent spinules. Male clasper as in figure (Plate IV, fig. 10). Length (male, female), 5.4–6.3 mm.; width, 1.5–1.8 mm.

This species is recorded in the literature from Mexico, Guatemala, Panamá, and Brazil. The above description is taken from a male from Bugaba, Panamá, and a female from Cahabón, Vera Paz, Guatemala, both collected by Champion and listed by him in Biologia Centrali Americana. In each of these specimens there is more of a rufous tinge to the dark color than is shown in Champion's figure.

Alloeorrhynchus flavomarginatus n. sp.

Elongate-oblong, smooth, shiny, moderately thickly clothed with long semi-erect hairs; rufo-piceous, the lateral margins of pronotum (extending onto pleura), coastal margins of hemelytra to middle of cuneus, rostrum, legs, and venter flavotestaceous. Head rufo-piceous, the apex pale; broader than long and distinctly broader than apex of pronotum. Eyes very prominent, each subequal in width to vertex. Ocelli distinct. Antennal segment I longer than width of vertex with one eye; II four-fifths longer than I (36 : 20) ; (III and IV missing). Rostrum extending onto mesosternum, segment II subequal to I of antennae, III three-fourths as long as I. Pronotum broader than long (52 : 40), the length of anterior lobe equal to width of head through eyes, posterior lobe three-fifths as long as anterior lobe, basal margin slightly reflexed and feebly emarginate. Scutellum about as in *trimacula*. Hemelytra shiny; rufo-piceous, the entire costal margin to apex of cuneus paler, tending to flavo-testaceous proximally; clavus and corium with the usual rows of distinct punctures along the veins. Anterior femora with the dentate ampliation placed before the middle. Mesopleura rufo-piceous, shiny. Metapleura brown, dull, rugulose; the canal prominent. Venter somewhat embrowned, with a broad submarginal stripe on each side (converging posteriorly) rufo-piceous to brown; clothed with numerous scattered long hairs. Connexivum without black patches of spinules. Length, 5.07 mm.; width, 1.57 mm.

Holotype: winged female, Essequibo R., Br. Guiana, A. Busck, collector, July, 1921. Type deposited in U. S. National Museum. This species is perhaps most closely related to *vittativentris* Stål and *trimacula* Stein but may be readily distinguished from either by its different coloration.

Alloeorrhynchus nigrofasciatus n. sp.

Elongate-oblong, smooth, shiny, moderately thickly clothed with rather long, semi-erect hairs. Head piceous black, broader than long and distinctly broader than apex of pronotum. Eyes moderately prominent, the width of each less than width of vertex. Ocelli distinct. Antennae testaceous; length of segment I scarcely equal to width of vertex with one eye; II about twice as long as I (28:14), III and IV missing. Rostrum flavo-testaceous, the basal segment embrowned, segment II about a third longer than antennal I; III and IV conjoined slightly longer than II.

Pronotum flavo-testaceous, the narrow collar embrowned, a fascia on basal margin (considerably widened on disc) piceous; broader than long (46:40), the anterior lobe scarcely twice as long as posterior; the basal margin slightly rounded. Scutellum brown, dull, bifoveate on the disc, with a median impression before the apex; the apex slightly expanded and distinctly bifid. Hemelytra shiny throughout; rufo-piceous, the embolium, basal half of the corium, and outer basal half of clavus flavo-testaceous; membrane fuscous. Legs flavo-testaceous, the intermediate and posterior femora annulate with reddish brown before their apices; anterior and intermediate femora ampliately dentate before the middle. Mesopleuron piceous black, shiny, rugulose; metapleuron dull. Meso- and metasternum longitudinally carinate down the middle. Venter flavo-testaceous, with a macula on each side at the base, and the genital segments embrowned. Connexivum above broadly exposed, segments II–V, each with a small patch of recumbent, piceous spinules. Length, 4.4 mm.; width, 1.38 mm.

Holotype, winged female, Alta V. Paz, Guatemala. Type deposited in U. S. National Museum. This pretty little species is at once recognizable from our other members of the genus by the piceous basal fascia of the pronotum. The eyes are distinctly smaller than in *flavomarginatus* n. sp., and the legs much shorter than in that species.

Alloeorrhynchus delicatus n. sp.

Small, elongate-oblong, shiny, clothed with a few fine hairs; flavo-testaceous, the head, posterior lobe of pronotum, scutellum, cuneus, mesopleuron and mesosternum reddish brown. Head short, broader than long and distinctly broader than apex of pronotum. Eyes fairly large, each about one-half as wide as vertex. Ocelli prominent. Segment I of antennae flavo-testaceous, subequal in length to width of vertex with an eye (11:12); (remaining segments missing). Rostrum reaching onto mesosternum, segment II one-third longer than antennal I, III five-sixths as long as II. Pronotum broader than long (39 : 33), the posterior lobe (median measurement) one-half as long as anterior lobe. Scutellum opaque, clothed with numerous, long, semi-erect hairs, bifoveate on the disc; the apex slightly expanded, bifid. Hemelytra shiny throughout, minutely punctate, the clavus and corium with the usual rows of distinct punctures along the veins; membrane transparent. Legs pale throughout, the anterior and intermediate femora widened and armed before the middle with a stout tooth, minutely denticulate from there to apex; anterior and intermediate tibiae serrately dentate within, the former widened on apical third and provided with the usual spongy fossa at the apex. Meso- and metasternum longitudinally carinate down the middle. Connexivum above and beneath with an interrupted, submarginal, piceous line of fine recumbent spinules. Length, 3.94 mm.; width, 1.09 mm.

Holotype, male, Ancon, C. Z., Panamá, May 12, 1911, A. H. Jennings. *Allotype,* female, and *paratypes,* one male and two females, taken with type. Type deposited in U. S. National Museum. This delicate little species is closely related to the following (*nigrolobus* Barber), from which it may be readily separated by its larger eyes, the presence of the line of recumbent spinules on the connexivum, and the darker apical part of corium. The scutellum is not so strongly contracted apically as in *nigrolobus.* The margin of the propleuron is deeply notched just behind the acetabula and the notch provided with a distinct tooth-like projection.

Alloeorrhynchus nigrolobus Barber

1922. *Alloerrhynchus nigrolobus* Barber, Proc. Ent. Soc. Wash., XXIV, p. 103.

Size, form, and color markings about as in *A. delicatus* n. sp., the paler markings tending to a testaceous, the cuneus only feebly infuscate. Head as long as broad, its width through the eyes slightly greater than width of apex of pronotum. Eyes rather small, not prominent, the width of one less than one-half of width of vertex. Ocelli distinct. Antennae flavo-testaceous, the apical segments somewhat embrowned; moderately thickly clothed with short hairs, segment I subequal in length to width of vertex with one eye; proportion of segments, I : II : III : IV = 12 : 25 : 22 : 20. Rostrum extending onto mesosternum, segment II subequal to segment I or antennae; III and IV together equal to II. Pronotum with the anterior lobe slightly darker and broader than in *delicatus,* its sides less strongly rounded. Scutellum paler and more constricted apically than in *delicatus.* Hemelytra lighter, more pilose, the corium and embolium more distinctly punctulate, corium only slightly darkened apically. Venter darker at apex, the connexivum without the submarginal row of black spinules. Length, 3.67 mm.; width, 1.06 mm.

Nigrolobus was described from Brownsville and San Antonio, Texas, and has heretofore been known only from there. The above description is taken from a specimen from Bowie, Arizona, collected July 15, 1917, by Dr. H. H. Knight and kindly compared with the types of *nigrolobus* in the National Museum by Dr. C. J. Drake. Specimens are also at hand from Bonita, Arizona, July 16, 1917, and Lordsburg, N. Mex., July 13, 1917, H. H. Knight, collector. In addition to the differences pointed out above the shape of the ostiolar canal and of the male clasper will readily separate this species from its ally *A. delicatus* n. sp.

Genus PAGASA Stål

1862. *Pagasa* Stål, Rio Jan. Hemip., II, p. 60.
1865. *Pagasa* Stål, Hemip. Afr., III, p. 38.
1873. *Pagasa* Stål, Enum. Hemip., III, pp. 107, 108.
1899. *Pagasa* Champion, Biol. Centr. Amer., Heter., II, p. 297.
1909. *Pagasa* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, p. 25.

Oblong to subelongate, narrowed anteriorly, shiny, the head, pronotum, and scutellum thinly clothed with long, semierect hairs, hemelytra pilose. Head conically produced in front of the eyes. Eyes large, almost or touching apex of pronotum. Ocelli distinct, the distance between them greater than their distance from the eyes. Antennae inserted on side at about middle of anteocular part of head, rather short, segments I, II, and III somewhat thickened, IV and V slenderer and clothed with longer hairs; the supplementary segment (II) about one-half as long as I; I short, only slightly surpassing apex of head. Rostrum rather short, stout. Pronotum constricted distinctly behind the middle; anterior lobe narrowed toward apex, apical collar narrow, indistinct; posterior lobe, broad, its basal margin slightly sinuate. Scutellum moderately large, sub-equilateral, bifoveate on the disc. Hemelytra when developed with cuneus well marked off; membrane in macropterous form with three oblong cells from which many veins radiate to the margin. Legs rather short, thickly pilose, the anterior femora strongly incrassate, armed beneath with piceous teeth; anterior tibiae serrately dentate within, strongly widened inwards at apex and provided there with a large spongy fossa. (Type of genus, *Pagasa pallidiceps* Stål.)

Pagasa is known only from the Nearctic and Neotropical realms. It is undoubtedly closely related to *Prostemma* Léon Dufour which is rich in species in the Palaearctic regions. Our forms are often dimorphic in regard to wing development. The shape of the anterior legs, the length of the rostral segments, and the shape of the ostiolar canal vary much in the different species. Of the nine described species only three have been recorded from our region.

Key to Species of Pagasa

1. Pronotum with a triangular ochraceous patch on anterior lobe at apex; anterior tibiae strongly curved inwards, gradually widened from base to apex.......... *luteiceps* (Walker), p. 21.
   Pronotum entirely piceous or nigro-piceous; anterior tibiae not curved inwards; the apex broadly and angularly dilated..........2
2. Segment II of rostrum extending beyond base of head; anterior tibiae broadly and suddenly dilated along apical two-fifths; hemelytra in greater part opaque.......... *pallipes* Stål, p. 22
   Segment II of rostrum scarcely attaining posterior margin of eyes; anterior tibiae angularly dilated within to apex; hemelytra shiny (*fusca*)..........3
3. Legs pale testaceous .... *fusca* (Stein), p. 24.
   Legs piceous black .... var. *nigripes* Harris, p. 26.

Pagasa luteiceps (Walker).

1873. *Prostemma luteiceps* Walker, Cat. Hem. Heter. Br. Mus., VII, p. 135.

1900. *Pagasa luteiceps* Champion, Biol. Centr. Am., Heter., II, p. 298, Tab. XVIII, figs. 16, 16a.

1909. *Pagasa luteiceps* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, p. 27.

Oblong, smooth, pilose and somewhat setose, shiny, the scutellum and greater part of hemelytra opaque; piceous, the head and a triangular patch on apex of pronotum ochraceous, the scutellum and hemelytra excepting embolium and cuneus, ochraceous to testaceous, somewhat variegated. Antennae, rostrum and legs fusco-testaceous. Head slightly broader than long, embrowned beneath. Eyes large, the width of one less than width of vertex. Ocelli prominent, far apart. Antennae paler at base, segment I (16) scarcely as long as an eye; III almost twice as long as I, distinctly less than width of head through eyes (31:34), supplementary segment (II) one-half as long as I. Rostrum reaching upon mesosternum, segment II not surpassing middle of eyes; III about a third longer than II.

Pronotum broader than long (macropterous male, 68: 55); anterior lobe broad, about two and a half times as long as posterior lobe (median measurement); basal margin angularly emarginate. Scutellum large, with a few scattered punctures basally and two piceous foveae on disc, the apex slightly produced. Hemelytra clothed with somewhat reclining hairs, opaque, the embolium and costal margin of cuneus shiny brown; the corium with one and the clavus with three rows of distinct punctures; membrane smoky, the veins paler. Anterior femora greatly incrassate, their length (measured beneath) about twice their thickness (43: 21), the lower surface for its entire length densely spinose; anterior tibiae strongly curved inward, widened apically from the base, the inner surface beset with a row of curved piceous spines. Intermediate and posterior tibiae (the latter more sparingly) spinose and also setose. Metasternum longitudinally carinate down the middle. Metapleuron opaque, rugulose, the ostiolar canal distinct. Venter shiny. Clasper with the apex truncate (Plate IV, fig. 2). Length, 6.6 mm.; width, 2.07 mm.

P. luteiceps is said to be closely related to the Brazilian species, *P. pallidiceps* Stål. It has heretofore been recorded from Mexico and Venezuela. The above description is made from a winged male from Tobago Id., Panamá. This species may be readily separated from its congeners by its color markings, differently constructed anterior femora, and curved anterior tibiae. Nothing seems to be known regarding its biology.

Pagasa pallipes Stål.

1873. *Pagasa pallipes* Stål, Enum. Hemip., III, p. 108.
1899. *Pagasa pallipes* Champion, Biol. Centr. Amer., Heter., II, p. 299, Tab. XVIII, figs. 18, 18a.

1909. *Pagasa pallipes* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, p. 29.
1914. *Pagasa pallipes* Barber, Bul. Am. Mus. Nat. Hist., XXXIII, p. 502.

Moderately elongate, smooth, pilose, and also sparsely setose; shiny, the scutellum, central portion of hemelytra, and metapleura dull; nigro-piceous, the antennae, rostrum, and legs testaceous. Head equally as long as broad. Eyes large, width of one of them equal to that of vertex. Ocelli far apart. Antennae moderately long, segment I one-fourth shorter than an eye; III more than twice as long as I, subequal to width of head through eyes; supplementary segment (II) about half as long as I; IV and V slender, thickly pilose; proportion of segments, I : II : III : IV : V = 15 : 7 : 35 : 36 : 40. Rostrum fairly long, segment II longest, surpassing apex of pronotum, its length greater than III of antennae; III and IV conjoined slightly longer than II.

Pronotum broader than long (macropterous male, 73 : 62), collar narrow, indistinctly marked off, anterior lobe long, transverse impression with a few punctures, posterior lobe slightly more than one-third as long as anterior, basal margin feebly sinuate inwards at the middle. Scutellum dull, with a few scattered punctures on the base, the disc bifoveate. Hemelytra dull, the embolium, costal margin of cuneus and outer portions of corium and clavus shiny; with rows of punctures as in *luteiceps;* membrane smoky, the veins rather indistinct. Anterior femora strongly incrassate, length about three times depth (50 : 17); armed beneath, excepting apical and basal one-fourths, with two indistinct rows of piceous spines. Anterior tibiae broadly, angularly dilated on apical one-third, spinose within, the spongy fossa at apex about one-half as long as tibia itself. Intermediate and posterior tibiae with several stout spines along their inner surfaces. Venter on either side with a large submarginal impression at base of second segment, the impression fringed with long hairs, its bottom distinctly pitted. Clasper with the apex broadly rounded (Plate IV, figure 1). Length, 7.5 mm.; width, 2.2 mm.

Pallipes was originally described from Texas and has since been recorded from Florida, Kansas, and Utah. The above description is taken from a male and female (both macropterous) from San Antonio and Victoria, Texas, respectively. Specimens from Dunedin and Royal Palm Park, Florida, collected by Professor W. S. Blatchley, and from Brownsville, Texas, have been seen by the writer. Hussey (1922) has recorded this species from Michigan, but the author has yet to see a specimen from so far north. The nymphs are readily recognized by the enormously widened anterior tibiae, the apical fossa occupying more than half of the tibia in a fourth (?) instar nymph. The brachypterous form is said to have the hemelytra extending upon the second abdominal segment.

Pagasa fusca (Stein).

1857. *Prostemma fuscum* Stein, Berl. Ent. Zeit., I, p. 90.
1873. *Pagasa nitida* Stål, Enum. Hemip., III, p. 108.
1890. *Pagasa fusca* Reuter, Revue d'Ent., IX, p. 281.
1899. *Pagasa fusca* Champion, Biol. Centr. Amer., Heter., II, p. 299, Tab. XVIII, figs. 17, 17a.
1909. *Pagasa fusca* Reuter et Poppius Acta Soc. Sci. Fenn., XXXVII, p. 31.

Moderately elongate, smooth, setose, the antennae, hemelytra, legs, and venter also pilose; shiny, the scutellum and metapleura dull; piceous black, the posterior lobe of pronotum and hemelytra sometimes brownish; antennae, legs, and rostrum testaceous to flavo-testaceous. Head as broad as long. Eyes large, the width of one equal to that of vertex. Ocelli reddish, distinct, placed close to eyes. Antennae moderately long, segment I one-third shorter than an eye; III two and one-half times as long as I, equal to width of head through eyes; IV and V slender, thickly pilose; proportion of segments, I: II: III: IV: V = 13: 7: 29: 28: 28. Rostrum fairly short, stout, segment II not surpassing middle of eyes, its length only two-thirds of that of antennal III; III subequal to II.

Pronotum as broad as or distinctly broader than long, the collar very narrow, anterior lobe long, transverse impression with a few punctures, basal margin angularly and rather deeply emarginate. Scutellum with a few punctures on base, disc with numerous semi-erect long hairs, the foveae shallow. Hemelytra shiny, the veins rather prominent; clavus without a distinct row of punctures along inner margin, but it and corium with other punctures as in *pallipes*. Membrane smoky, when developed with three elongate cells from which numerous veins radiate. Anterior femora strongly incrassate, only about two and one-fifth times as long as thick (41:19), spinose beneath. Anterior tibia widened from apex outwards, spinose within, the fossa at apex distinctly less than one-half as long as tibia. Intermediate and posterior tibiae with a few elongate stout spines. Venter with only a faint impression at base of second segment on either side. Male clasper prolonged outwardly and upward at apex (Plate IV, fig. 3).

Brachypterous form: Smaller, more elongate, the pronotum scarcely as long as broad; hemelytra rather pointed, varying in length; abdomen conspicuously punctate. Length, 5.28–6.5 mm.; width, 1.5–1.8 mm.

Macropterous form: Pronotum distinctly broader than long (65:55). Membrane extending well beyond apex of abdomen. Length, 6.8 mm.; width, 1.95 mm.

Fusca was originally described from Pennsylvania. Its range is said to extend southward into South America. Specimens are at hand or have been examined from the following localities: Maine, New Hampshire, New York, New Jersey, Pennsylvania, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Mississippi, Kansas, Nebraska, South Dakota, Alberta, British Columbia, California, Arizona, Colorado, Texas, and Mexico. This species varies considerably in size. When the hemelytra are completely developed the membrane extends beyond the apex of the abdomen. It may be reduced, however, to where it just fails to cover the abdomen or is even entirely lacking. In the latter case the hemelytra extend only to the middle of the second abdominal tergite and are truncate at the apex. Many gradations between these extremes in wing development have been seen.

Biology: *P. fusca* is one of the ground inhabiting nabids. It is to be found usually in hot dry situations where the vegetation is very short. Here it runs about hiding beneath chips and bunches of grass and feeding upon other insects that it can overpower. The writer has observed it feeding upon leaf-hoppers and upon specimens of the Lygaeid, *Geocoris uliginosus* (Say), which form is itself predatory in nature and inhabits similar situations to that preferred by *P. fusca.* In Mississippi he has taken it in company with *Blissus leucopterous* Say and *Myodocha serripes* Oliv. The eggs are laid in the stems of plants. The nymphs are somewhat ant-like in appearance. The writer has taken the third instar (?) nymphs during the last week in May at Ames, and has had females deposit eggs in September which hatched within a few days in the writer's office. First and second instar nymphs have also been taken by the writer in Mississippi in September. Hibernation supposedly occurs in the adult form as a specimen labelled as having been taken beneath bark in January is at hand.

Pagasa fusca nigripes Harris.

1926. *Pagasa fusca nigripes* Harris, Ent. News, XXXVII, p. 287.

Similar in structure to typical *fusca*, but easily recognizable by the deeper black color of the body and especially by the black legs. Known only from Pingree Park, Colorado.

Subfamily NABINAE (Reuter)

1873. *Coriscina* Stål, Enum. Hemip., III, pp. 106, 110.
1890. *Arachnocorina* Reuter, Rev. d'Ent., IX, p. 293.
1890. *Nabina* Reuter, Rev. d'Ent., IX, p. 293.
1904. *Coriscidae* Uhler, Proc. U. S. Nat. Mus., XXVII, p. 363.
1904. *Nabidinaria* Distant, Fauna Br. Ind., Rhyn. II, p. 397.
1908. *Reduviolina* Reuter, Mém. Soc. Ent. Belg., XV, p. 129.
1908. *Nabinae* Oshanin, Verz. Palae. Hemip., I, p. 568.
1909. *Reduviolina* Reuter et Poppius, Acta Soc. Sci. Fenn., XXXVII, No. 2, p. 3.

Elongate to sub-elongate. Head more or less exserted, with a distinct collum, the eyes rather far from pronotum. Ocelli distinct or absent. Eyes prominent. Antennae long, 4-segmented, often with an obsolete ring-like segment at base of II. Rostrum slender. Pronotum with apical collar wide and rather distinctly marked off; constricted at or before the middle, the base truncate or emarginate. Scutellum moderately large. Hemelytra with clavus widened posteriorly. Metapleuron with ostiolar orifice indistinct or well developed, in the latter case the canal flattened and slightly curved forward or short and tuberculate. Anterior legs with coxae lengthened, femora more or less incrassate, and tibiae provided with an obsolete pad at the apex.

This subfamily contains by far the greater number of the North American species of Nabids. It is represented in our fauna by five genera.

Key to Genera of Nabinae

1. Anterior coxae not greatly elongate; anterior acetabula open behind; ocelli, in our species, always present (Tribe Nabini Van Duzee) 2
   Anterior coxae slender, rather greatly elongate; anterior acetabula closed behind; ocelli, in our species, always absent (Pl. III, fig. 13) (Tribe Gorpini Reut.) 4
2. Head short, strongly declivous; pronotum rather globose; scutellum small, the apex produced upwards into a distinct spine; ostiolar canal short, tuberculate ...... *Arachnocoris,* p. 27.
   Head moderately long, porrect; pronotum campanulate; scutellum moderately large, the apex not produced into an upward directed spine; ostiolar canal flattened, directed outward onto mesopleuron 3
3. Antennal I not twice as long as head, not suddenly thickened along apical third; membrane usually with closed discal cells; intermediate tibiae armed within with sharp spines or spine-like teeth .... *Nabis,* p. 32.
   Antennal I twice as long as head, suddenly and evenly thickened along its apical third; membrane with unclosed discal cells; intermediate tibiae unarmed within. *Metatropiphorus,* p. 71.
4. Scutellum equilateral; hemelytra strongly constricted before the middle; small species (less than 5 mm.) .... *Carthasis,* p. 74.
   Scutellum elongate; hemelytra with costal margins parallel; large slender species (12 mm.) .... *Neogorpis,* p. 82.

Genus ARACHNOCORIS Scott

1881. *Arachnocoris* Scott, Ent. Mo. Mag., XXVII, p. 272.

1890. *Arachnocoris* Reuter, Rev. d'Ent., IX, p. 292.

1894. *Velidia* Uhler, Proc. Zool. Soc. Lond. 1894, p. 206.

1908. *Arachnocoris* Reuter, Mém. Soc. Ent. Belg., XV, p. 129.

Body sub-elongate, shiny, pilose. Head short, rather strongly declivous. Eyes moderately large. Ocelli distinct. Antennae long, slender, pilose, segment I distinctly longer than head. Rostrum long, slender, extending onto metasternum; segment I twice as long as broad. Pronotum rather globose, strongly declivous anteriorly, only faintly constricted near the middle, the collar at apex well marked off; basal margin somewhat reflexed behind humeral angles, roundly emarginate at base of scutellum. Scutellum small, the apex produced into an acuminate spine. Hemelytra shiny, the clavus scarcely widened from base to apex of scutellum, the commissure longer than scutellum. Anterior legs with coxae only moderately long, femora of about equal thickness throughout their lengths, slightly curved, spinose beneath; tibiae slender, slightly longer than femora, somewhat curved, without apical pads. Mesopleuron shiny; metapleuron opaque, rugulose, the ostiolar canal tuberculate. Abdomen greatly narrowed basally, almost petiolate. (Type of genus, *Arachnocoris albomaculatus* Scott).

Arachnocoris was erected in 1881 for two new species of Nabids from South America. Reuter in 1890 constructed a separate subfamily for this peculiar genus, which however, he later (1908) rejected upon the discovery of *Pararachnocoris chloropterus* Reuter[1] from British Guiana. This latter seems to be a connecting link between the genus *Nabis* and the genus *Arachnocoris*. As now know *Arachnocoris* contains six species ranging from Panama and the West Indies southward to Brazil.

KEY TO SPECIES OF ARACHNOCORIS

1. Smaller (2.5 mm.); legs yellow, the femora annulate with black .... *berytoides* (Uhler), p. 28.
   Larger (4–5.5 mm.); legs piceous to rufo-piceous, sometimes with femora annulate with yellowish .... 2.
2. Segment II of venter with a transverse white fascia; metapleuron in greater part fuscous. Male with greatly incrassate intermediate femora; the clasper strongly curved, claw-like .... *albomaculatus* Scott, p. 29.
   Segment II of venter without transverse white fascia; metapleuron in greater part yellowish. Intermediate femora of male not greatly incrassate; the clasper slender lance-like .... *trinitatis* Bergroth, p. 31.

Arachnocoris berytoides (Uhler).

1894. *Velidia berytoides* Uhler, Proc. Zool. Soc. Lond., 1894, p. 207.

1914. *Arachnocoris berytoides* Bergroth, Ent. Mo. Mag., L, p. 116.

[1] Unfortunately *Pararachnocoris* was by typographical error spelled *Parachnocoris* originally and this error has been perpetuated in most of the literature. Reuter however, plainly meant, and he so states later, that the name should be *Pararachnorcoris*.

"Long, subcylindrical, griseo-fuscous, widest at the base of the pronotum. Head highly polished, black at base and between the eyes, the face, cheeks, and rostrum yellow; the antennae dusky testaceous, annulated with black at the ends of the joints, and with a white band at the base of third and fourth joints, the basal joint with a broader black band a little way behind the tip. Pronotum greyish testaceous; the posterior lobe strongly punctate, the callosities black and polished, with a groove in the middle between them; the collum in front of these polished, yellow; the intrahumeral and the posterior border black, with the edge yellow; the pleural flaps punctate, pale yellow; humeri with a small whitish callosity in the angle. Scutellum mostly greyish yellow, with the apical point white. Legs yellow, all the femora with a black band before the tip, and the middle and posterior pairs, especially marked with about three narrow black bands; the tips of tibiae and of tarsi also black. Venter smooth, dull flavo testaceous, with a large spot on each side of base and the last two segments mostly black.

Length to tip of venter $2\frac{1}{2}$ mm.; width of pronotum $\frac{2}{3}$ mm.

Only one specimen was obtained. It was found at Balthazar, on April 24, at an elevation of 250 feet above tide level, near the shady bank of a stream; beaten from a mass of bush and decaying leaves."

This species is known only by the type specimen in the British Museum of Natural History from Trinidad, West Indies. The above is Uhler's original description.

Arachnocoris albomaculatus Scott.

1881. *Arachnocoris albomaculatus* Scott, Ent. Mo. Mag., XXVII, p. 273.

1890. *Arachnocoris albomaculatus* Reuter, Rev. d'Ent., IX, p. 292.

1893. *Herdonius panamensis* Distant, Biol. Centr. Amer., Heter., I, p. 419, Tab. XXXVI, fig. 13.

1908. *Arachnocoris albomaculatus* Reuter, Mém. Soc. Ent. Belg., XV, p. 129.

1925. *Arachnocoris albomaculatus* Myers, Jour. N. Y. Ent. Soc., XXXIII, pp. 136–146, Pl. VI.

Slender; pilose, shiny, piceous brown, the pronotum excepting collar and reflected basal margin black; apex of scutellum, a transverse fascia at apex of clavus (widening forwards on embolium to near the base), and apex of cuneus white. Under surface rufopiceous, the gula, collar of pronotum beneath, margins of anterior and intermediate acetabula, a spot on base of mesopleuron and another on ostiolar canal, a broad fascia on basal half of second segment of venter, a median interrupted line on segments II and III of venter and the apical margin of segment IV beneath, and prominent calloused spots on the first four connexival segments white. Head short, as broad as long. Eyes moderately large. Ocelli prominent, far apart. Antennae long, slender, pilose; flavotestaceous, the median portion of segment II, all of III and the base of IV darker; segment I slightly longer than width of head through eyes; proportion of segments, I:II: III: IV = 24 : 38 : 51 : 39. Rostrum piceous, the basal segment paler, more than twice as long as broad; II and III subequal, each equal to I of antennae; IV half as long as III, extending between hind coxae.

Pronotum thickly and coarsely punctate behind the transverse impression, with a few fine punctures in front; thickly clothed with short, even, erect pubescence; the basal margin behind the humeral angles paler, reflected, deeply emarginate in front of scutellum. Scutellum small, with a few erect fine hairs, its base impressed and finely punctate; the apical half white, spiniform. Hemelytra rather strongly constricted to a point opposite apex of clavus, smooth, shiny, the veins and the costal margin beset with a few fine hairs. Membrane smoky, densely clothed with very short, reclining pubescence. Anterior and intermediate legs piceous brown, the femora strongly punctate above, their apices and the tibiae and tarsi paler; the tibiae with an ivory spot on the outer surface near the base. Anterior femora of about equal thickness throughout, spinose beneath, somewhat curved posteriorly; anterior tibiae slightly longer than femora, thickest basally, unarmed within and without fossae at their apices. Intermediate femora greatly incrassate (male), spinose at the apex beneath; intermediate tibiae slightly curved, thickest toward the base and there minutely spinose within. Metapleuron fuscous, opaque, rugulose. Venter rather strongly narrowed and somewhat keeled at base, finely punctate, pilose. Male clasper hook-like (Plate IV, fig. 4). Length 5.45 mm.; width, 1.25 mm.

A. albomaculatus was originally described from Rio Janeiro. The above description is made from a male specimen belonging to the Drake collection. It bears the label Tabernilla, Canal Zone, Panamá, June 4, '07, Aug. Busck collector, and is undoubtedly the specimen that Bergroth (Ent. Mo. Mag., Vol. 50, 1914, p. 117) had previously listed from Panamá. It differs from Scott's description in the proportions of the antennal and rostral segments, and in the absence of the spine on the posterior trochanters. Also it is to be noted that the color (Scott described it "Pitchy black") is more of a brownish, the pronotum alone being pitchy black. In the specimen before me the band on the base of the segment of venter seems to extend even across on the dorsal side of abdomen. In view of the points that are at variance with Scott's description there would be some hesitation in identifying the specimen present as *albomaculatus* were it not for the fact that Reuter after examination of a specimen from Rio Janeiro pointed out that Scott had probably erred in his description of the antennae and rostrum. Bergroth who studied Scott's type at the British Museum concurred in this view even though he failed to recognize the sexes. In the specimen at hand the claspers are very prominent.

Biology: This remarkable insect is known to inhabit the webs of certain spiders where it lives suspended upside down apparently preying upon insects caught therein. Myers (1925) has published a rather full discussion of the peculiar body modifications and color schemes that so remarkably adapt the adult and its nymphs for such a life. Nothing is known of the eggs and younger instars.

Arachnocoris trinitatis Bergroth.

1916. *Arachnocoris trinitatis* Bergroth, Proc. U. S. Natl. Mus., LI., p. 232.

Closely related to *A. albomaculatus* but smaller and slightly paler; the males with very differently shaped claspers and without greatly incrassate intermediate femora. Head short, strongly declivent. Antennae fusco-testaceous, the base and apex of segment I, apex of II, and the apical two thirds of IV pale to whitish; proportion of segments, 20: 33: 42: 30. Rostrum piceous, extending between hind coxae; proportion of segments, II: III: IV = 22: 19: 11.

Pronotum less globose than in *albomaculatus,* the color distinctly paler than there (more of a brownish testaceous), the transverse impression much more distinct, the collar wider, and the basal margin more broadly emarginate. Scutellum about as in *albomaculatus*, the apical spine shorter. Hemelytra as in *albomaculatus,* the transverse band at apex of commissure scarcely widened forwards on embolium. Legs piceous brown, the extreme apex of each femur and base of each tibia yellowish to reddish. Anterior and intermediate femora of about equal thickness, spinose beneath; posterior femora slender and curved, and with a rather broad, indistinct yellowish annulation before the distal third. All tibiae and tarsi very slender. Metapleuron in greater part yellowish; opaque, rugulose. Venter constricted basally as in *albomaculatus,* but less thickly pilose and the color paler, the second segment without the transverse white band and the median white line; the fifth segment with a prominent raised ivory submarginal spot on each side. Connexival segments marked as in *albomaculatus,* but the spots much smaller on the basal segments and more prominent on the fourth, fifth, and sixth segments. Genital segments large, the clasper rather long and lance-like (Plate IV, fig. 7). Length 4.41 mm.; width, 1.04 mm.

This species was described from Trinidad, West Indies, and is known only by the type specimens in the collection of the U. S. National Museum. The above description is made from two of the paratypes (both males) kindly sent to me for study by Mr. W. L. McAtee. They are labelled as having been taken at Montserrat, June 27, Aug. Busck, collector. These specimens agree quite well with Bergroth's description, but in neither is the second antennal segment twice as long as the first nor are the calloused ivory spots lacking on the fourth and sixth connexival segments as that author states. The species is closely related to *A. albomaculatus* and undoubtedly has similar habits.

Genus NABIS Latreille

1802. *Nabis* Latreille, Hist. Nat. Ins., III, p. 248.

1807. *Nabis* Latreille, Genera Crust. Ins., III, p. 127.

1837. *Reduviolus* Kirby, Richardson's Fauna Bor. Am., IV., p. 279.

1840. *Nabis* Westwood, Intr. Mod. Classif. Ins., II, Synop., p. 120.

1873. *Coriscus* Stål, Enum. Hemip., III, p. 112.

1890. *Nabis* Reuter, Revue d'Ent., IX, p. 293.

1900. *Reduviolus* Kirkaldy, Entomologist, XXXII, p. 242.

Elongate-oblong, narrowed anteriorly; more or less opaque, pilose. Head rather long, horizontal, produced before and behind the eyes. Eyes large, well removed from apex of pronotum. Ocelli (in our species) distinct, about as far from eyes as from each other. Antennae long, pilose, segment I thickest, distinctly surpassing apex of head. Rostrum slender, segment I thick, as broad as long.

Pronotum strongly narrowed anteriorly, transversely constricted near the middle, the anterior lobe with a wide distinct collar; the posterior lobe usually arched, its basal margin truncate. Scutellum equilateral, somewhat impressed on the disc, with a smooth callosity on each side. Hemelytra often abbreviated; the membrane when developed with three elongate cells from the margins of which numerous veins radiate. Legs long, the anterior femora incrassate, the anterior tibiae shorter than femora, dentate within and with a small fossa at apex. Metapleura dull, the ostiolar canal flattened, extending outward to middle of evaporative surface and curved anteriorly. [Type of genus, *Nabis ferus* (Linn.)].

The genus *Nabis* includes the most numerous and the better known members of the family occurring in North America. It is a large genus containing many species throughout its almost world-wide range. Reuter has divided the genus into several distinct groups or subgenera. Evidence at hand, however, indicates that these may need to be recharacterized and this the writer hopes to do when more material from other faunal regions becomes available.

Key to the Subgenera and Species of Nabis

1. Head behind the eyes parallel-sided or nearly so; body in greater part grey or brownish in color 2

   Head strongly and obliquely narrowed behind the eyes; body shiny black, with antennae, rostrum, legs, and margin of connexivum yellowish (Subgenus *Nabicula* Kirby).
   subcoleoptratus (Kirby), p. 37.

2. Anterior and intermediate femora armed beneath with minute short, rather blunt, piceous teeth; tibiae annulate throughout their entire length; (Subgenus *Hoplistoscelis* Reuter) ... 3

   Anterior and intermediate femora unarmed or with only minute piceous spine-like setae, never with short teeth; tibiae not annulate, or, if so, only at the base and apex 7

3. Posterior tibia with numerous long hairs that arise at right angles from its surface, the hairs being about twice as long as tibia is thick .... *heidemanni* (Reut.), p. 39.

   Posterior tibia with numerous shorter hairs that arise at an acute angle and that are never twice as long as the tibia is thick 4

4. First antennal segment equal to or slightly longer than width of head through eyes; anterior femora at least four times as long as thick (depth) .... *sordidus* Reut., p. 41.
   First antennal segment less than width of head through eyes; anterior femora less than four times as long as thick 5
5. Anterior femora only three times as long as thick; size larger, 7–8 mm. .... **dentipes** n. n., p. 43.
   Anterior femora more than three times as long as thick; size smaller 6
6. Anterior femora three and one-third times as long as deep. *nigriventris* Stål, p. 44.
   Anterior femora three and two-thirds times as long as deep. **deceptivus** n. sp., p. 45.
7. Posterior lobe of pronotum strongly punctate; hemelytra distinctly constricted before the middle, the costal margin ciliate; femora annulate before the apex; posterior tibiae clothed with long, sub-erect hairs. (Subgenus *Lasiomerus* Reuter) 8
   Posterior lobe of pronotum not or only very faintly punctate; costal margins of hemelytra about parallel, clothed with only a few shorter hairs; femora usually not annulate before apex; tibiae clothed with shorter hairs which arise at a sharp angle from its surface 11
8. Ostiolar canal gently curved forward, flat, not sharply raised from the surface of the metapleuron; anterior lobe of pronotum not or only slightly arched; segments II and III of rostrum subequal in length; larger (6 mm. or more) 9
   Ostiolar canal directed posteriorly, high, distinctly and sharply raised from the surface of the metapleuron; anterior lobe of pronotum rather strongly arched; segment II of rostrum distinctly longer than III; small (3.6–3.9 mm.). *panamensis* Harris, p. 46.
9. Body slender, elongate; anterior and intermediate femora each with a row of long, rigid, spine-like setae on the posterior surface below .... *spinicrus* Reut., p. 47.
   Body oblong to oblong-ovate; anterior and intermediate femora without rigid, piceous, spine-like setae 10
10. Segment I of antennae about as long as pronotum, its length $1\frac{3}{4}$ times width of head through eyes; larger (8–9 mm.). *annulatus* Reut., p. 49.
   Segment I of antennae distinctly shorter than pronotum, its length less than $1\frac{1}{2}$ times width of head through eyes; smaller .... *constrictus* Champ., p. 51.

11. Body elongate; antennal I always distinctly longer than width of head through eyes; scutellum with a prominent, depressed, semicircular, shiny spot on each side at the base; macropterous form rare. Brachypterous form with elytra not extending beyond third abdominal segment; abdomen pale above, nigro-vittate (subgenus *Dolichonabis* Reuter) 12

Body usually broader, oblong-ovate; scutellum with depressed shiny spots at base absent or only obsoletely developed; macropterous form common. Brachypterous form rarely with elytra not extending beyond middle of abdomen and then antennal I is scarcely or not longer than width of head through eyes (subgenus *Nabis* Latr.) 14

12. Body greatly elongate; antennal I usually about four times as long as width of head between the eyes; anterior femora about six times as long as thick; length (male-female, 9–12 mm.) .... *propinquus* Reut., p. 51.

Body shorter, the abdomen of female more expanded; length of antennal I not or scarcely more than three time the width of head between the eyes; anterior femora usually not more than five times as long as thick 13

13. Length of segment II of rostrum slightly greater than width of head through eyes; antennal IV distinctly longer than antennal I; brachypterous form with elytra truncate at apex .... *limbatus* Dahlb., p. 53.

Segment II of rostrum usually equal to width of head through eyes; antennal IV shorter than I; brachypterous form with elytra obliquely narrowed and somewhat pointed at apex. *nigrovittatus* Sahlb., p. 54.

14. First segment of antennae equal in length to width of head between eyes .... *gerhardi* Harris, p. 55.

First segment of antennae much longer than width of head between eyes 15

15. Head somewhat narrowed behind eyes; scutellum with semicircular shiny spot in each basal angle distinct but obsoletely developed; brachypterous form most common, their hemelytra extending usually not beyond middle of abdomen 16

Head not narrowed behind eyes; scutellum without semicircular shiny spots at basal angles; smaller species (usually less than 8 mm.); brachypterous form with hemelytra always extending almost to or beyond apex of abdomen 17

16. First antennal segment slightly longer than width of head through eyes; head, anterior lobe of pronotum, and abdomen above in greater part black; male clasper with a backward

projecting spine-like hook on the dorsal edge near the base of blade .... *flavomarginatus* Scholtz, p. 56.

First antennal segment slightly shorter than width of head through eyes; head, anterior lobe of pronotum and abdomen above in greater part testaceous to brownish; male clasper without basal hook on blade .... *vanduzeei* (Kirk.), p. 58.

17. First antennal segment shorter than width of head through eyes; hemelytra concolorous dull yellowish brown with three brown spots on each, thickly clothed with short, recumbent, golden pubescence; male clasper with narrow, elongate, lance-like blade .... *lovetti* Harris, p. 59.

First antennal segment equally as long as or longer than width of head through eyes (if shorter, then the color is greyish testaceous); hemelytra yellowish brown to greyish testaceous, often speckled or mottled with darker, sparsely clothed with yellowish to greyish pubescence; male clasper with broad blade 18

18. Color in greater part yellowish to reddish brown; segment IV of antennae longer than segment I 19

Color in greater part grey to greyish testaceous; segment IV of antennae subequal to I or slightly shorter 21

19. Head beneath in greater part fuscous to black; posterior tibiae dotted with fuscous; brachypterous form with closed cells in the membrane; male clasper with long sinuated stem.
roseipennis Reut. (Plate I), p. 60.

Head beneath in greater part yellowish to testaceous; posterior tibiae usually immaculate; male clasper with short rectangular stem 20

20. First antennal segment thickened distally, somewhat sinuate above; brachypterous form common, usually with no closed cells in membrane; diameter of blade of male clasper greater than that of an eye viewed from above.
rufusculus Reut., p. 62.

First antennal segment scarcely thickened distally, from above almost straight; brachypterous form unknown; diameter of blade of male clasper equal to that of an eye.
kalmii Reut., p. 64.

21. Length of first antennal greater than that of head, two-fifths greater than width of head through eyes; body narrow, linear; hemelytra translucent, shiny, never speckled; legs concolorous with body; brachypterous form unknown.
capsiformis Germ., p. 64.

Length of first antennal less than that of head, never more than one-fifth greater than width of head through eyes; body broader; hemelytra often distinctly speckled with fuscous dots 22

22. Posterior tibiae usually dotted with fuscous; connexivum usually with black spots in basal angles of its segments, sometimes pale throughout (var. *uniformis*, n. var.); first antennal segment equal in length to width of head through eyes; pronotum broader than long; diameter of blade of male clasper distinctly less than that of an eye viewed from above .... *alternatus* Pshly., p. 66.

Posterior tibiae always immaculate; connexivum pale throughout; length of first antennal less than width of head through eyes, or if longer (*N. ferus* var. *pallidipennis* n. var.) then is the pronotum as long as broad and the hemelytra not speckled; male clasper with diameter of blade equal to that of an eye viewed from above 23

23. Length of an eye equal to width of vertex; second antennal segment three-fourths longer than first. First antennal segment shorter, or greater (var. *pallidipennis*), than width of head through eyes. Macropterous form most common. *ferus* (Linn.), p. 68.

Length of an eye slightly greater than width of vertex; second antennal segment only about one-half longer than first; length of first antennal segment always distinctly less than width of head through eyes. True macropterous form unknown .... *inscriptus* (Kirby), p. 70.

Nabis subcoleoptratus (Kirby).

1837. *Nabicula subcoleoptrata* Kirby, Richardson's Fauna Bor. Am., IV, p. 282.

1869. *Nabis canadensis* Provancher, Nat. Can., I, p. 211.

1872. *Nabis subcoleoptratus* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 81.

1873. *Coriscus subcoleoptratus* Stål, Enum. Hemip., III, p. 112.

1900. *Coriscus subcoleoptratus* Howard, U. S. Dept. Agr., Div. Ent., Bull. 22, N. S., p. 27, fig. 20.

1901. *Reduviolus subcoleoptratus* Kirkaldy, Wien. Ent. Zeit., XX, p. 222.

1921. *Nabis subcoleoptratus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 1.

Oblong-ovate, impunctate, thinly pilose; shiny black, a short line on vertex along inner margin of each eye (extending inward to ocelli), the antennae, rostrum, legs, margins of acetabula, and border of connexivum yellow to testaceous. Head a little longer than broad, slightly declivent in front, the post-ocular part rather long, strongly obliquely narrowed backwards. Eyes large, the width of one about equal to one-half of distance between them. Ocelli distinct placed slightly closer to eyes than to each other. Antennae long, clothed with short hairs, the apical segments more thickly so; segment I subequal to width of head through eyes (42: 43), proportion of segments, 42: 74: 70: 45. Rostrum long, segment II subequal to or slightly longer than antennal I, III faintly longer than II. Legs long, the anterior femora thickest near the base, about four times as long as deep, thickly clothed beneath with short hooked hairs; intermediate femora with piceous spinules within. Venter rather thickly pilose. Male rather elongate-ovate; genital segments large, the clasper with a broad stem and broad semi-circular blade (Plate II, fig. 1).

Brachypterous form: Pronotum subconical, longer than broad, the anterior lobe arched. Scutellum small. Hemelytra reaching to middle of second abdominal segment, obtusely rounded at apex; membrane narrow, its veins indistinct. Length (male-female), 8–9.5 mm.; width, 1.62–1.75 mm. (at abdomen, 3–3.8 mm.).

Macropterous form: Pronotum broader than long, the posterior lobe finely punctulate. Scutellum rather large, with a yellowish spot on either side of disc behind the middle. Hemelytra extending scarcely to or slightly beyond apex of abdomen, brownish black; membrane large, with three elongate closed discal cells. Wings with hamus arising at origin of decurrent vein. Length (female), 9.8 mm.; width, 2.28 mm. (at abdomen, 3.8 mm.).

Subcoleoptratus is one of the most common and best known members of the genus *Nabis* wherever it occurs. It constitutes according to Reuter a distinct subgenus (*Nabicula* Kirby) distinguishable by the shiny black color and the posteriorly narrowed hind portion of the head. *Nabis* (*Nabis*) *vanduzeei* Kirk., however, approaches it very closely in this last character. The long winged form occurs very seldom and is rare in collections. Of hundreds of specimens examined by me scarcely more than a dozen have been macropterous and then all of these were females. Perhaps the males never occur with fully developed wings. The yellowish markings vary from flavo-testaceous to dark testaceous and sometimes the connexival margin even shows a tendency toward a crimson. The lengths of the antennal segments vary considerably. Specimens have been examined from the following localities: Quebec, Maine, New Hampshire, New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Kansas, Colorado, South Dakota, North Dakota, Alberta, and British Columbia. The species is recorded by Van Duzee from Texas, but I have never seen a specimen from so far south.

Biology. The writer has worked out the complete life history of *N. subcoleoptratus* as it occurs in Iowa. Here the winter is spent in the egg stage within the stems of grasses. The eggs begin to hatch during the last week of April and the first of May and some of the nymphs have reached the imago stage by the first week of June. There are five nymphal instars. The nymphs are remarkably myrmecoid in appearance and often are to be found running about in company with ants. The ant-like appearance is produced by the color scheme—there being a white patch at the base of the abdomen on each side which, in contrast with the black body, causes the abdomen to appear strongly petiolate. Furthermore the nymphs have a peculiar ant-like movement. The younger ones remain close to the ground, but as they become older they spend the greater part of their time wandering up and down the stems of plants in search of prey. When thus occupied if they are disturbed by one wading through the grasses or sweeping with a net they will release their hold and fall to the ground. As in the nymphs (and adults) of all other nabids known to the writer, those of *subcoleoptratus* have well developed tibial combs and they not infrequently halt their wandering gait that they may draw an antenna or the rostrum through the apposed tips of the fore tibiae or brush the body with a mid or hind tibia. At Ames the species inhabits shady meadows and the margins of woods and streams. Its life cycle here seems to closely parallel that of the meadow plant bug (*Miris dolobratus* Linn.) which frequents similar situations and whose nymphs furnish abundant food for those of *subcoleoptratus.* There is only one generation per year.

Nabis heidemanni (Reuter).

1908. *Reduviolus heidemanni* Reuter, Mém. Soc. Ent. Belg., XV, p. 100.

Oblong or oblong-ovate, fuscous to fusco-testaceous, opaque, pubescent, also thickly pilose. Head about as broad as long, with two posteriorly converging fuscous lines above. Eyes large, the length of one equal to width of vertex. Ocelli placed closer to eyes than to each other. Antennae long, testaceous, segment I at base and II before the apex with fuscous rings; segment I equal to width of head through eyes (40:40); proportional lengths, 40:75:66:40. Rostrum with segments II and III subequal, each slightly longer than I of antennae (45:40).

Pronotum with a distinct median longitudinal line and more or less distinct pattern on anterior lobe, and five obscure lines on posterior lobe fuscous. Scutellum with a calloused white spot on each side. Hemelytra with moderately long, semierect pubescence, somewhat irregularly spotted with brownish fuscous, the veins lighter and often tending to crimson. Legs clothed with prominent erect or semierect hairs, fusco-maculate, the tibiae distinctly annulate. Anterior and intermediate femora armed beneath with distinct short grain-like teeth, the former about 3½ times as long as thick. Posterior tibia with its longer hairs about twice as long as the diameter of the tibia and standing out almost perpendicularly. Abdomen above densely clothed with prostrate, silvery, sericeous, pubescence; with a distinct naked patch at the base of each tergite in the median line, also each tergite on either side with a transverse naked patch. Connexivum testaceous sometimes obscurely marked with crimson, the segments each with a basal fuscous patch. Venter with a broad stripe on each side and a narrow median one fuscous, each segment with a conspicuous naked patch on either side next the connexivum. Male narrow, rather elongate; the clasper slender with a long blade (Plate II, fig 2).

Brachypterous form: Pronotum as broad as long (male, 51:52; female, 63:63), the anterior lobe rather strongly arched. Hemelytra extending onto the base of third dorsal segment, broadly rounded or almost truncate at apex; membrane very small, without veins. Length, 7.2–8.7 mm.; width, 1.56–1.92 mm. (at abdomen, 2.7–3.6 mm.).

Macropterous form: (female). Pronotum distinctly broader than long (80:63). Scutellum much larger than in brachypterous form. Hemelytra extending scarcely to tip of abdomen, obliquely narrowed from a point opposite middle of commissure; membrane with veins fuscous, broad and prominent. Length, 8.88 mm.; width, 2.28 mm. (abdomen, 3.5 mm.).

This is a distinct, easily recognizable species, originally described from California and heretofore known only from there. The above description is made from three specimens, the only examples that I have seen. These are, a brachypterous male (cotype) from Los Angeles, California (belonging to the U. S. National Museum), a brachypterous female from Mt. Moscow, Idaho, Oct. 10, 1916, A. C. Burrill, collector, and a macropterous female from Berkeley, California, Sept. 9, 1919, Henry Dietrich, collector. Nothing is known of the biology.

Nabis sordidus Reuter.

1872. *Nabis sordidus* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 85.
1872. *Nabis pallescens* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 85.
1873. *Coriscus sordidus* Stål, Enum. Hemip., III, p. 112.
1873. *Coriscus pallescens* Stål, Enum. Hemip., III, p. 112.
1890. *Nabis pallescens* Reuter, Rev. d'Ent., IX, p. 298.
1890. *Nabis sordidus* Reuter, Rev. d'Ent., IX., p. 299.
1899. *Nabis sordidus* Champion, Biol. Centr. Amer., Heter., II, p. 303, Tab. XVIII, figs. 26, 27, 28.
1908. *Reduviolus sordidus* Reuter, Mém. Soc. Ent. Belg., XV, p. 100.
1921. *Nabis sordidus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, figs. 3, 4.

Elongate to oblong-ovate; sordid pale testaceous, with fuscous markings in general as in *N. heidemanni.* Head slightly longer than broad. Eyes prominent, the length of one equal to width of vertex. Ocelli closer to eyes than to each other. Antennae with segment I slender than in related species, usually slightly longer than width of head through eyes; formula, 32 : 45 : 42 : 40. Rostrum with segments II and III subequal, each equal to or slightly longer than antennal I. Anterior and intermediate femora armed as in *heidemanni,* the teeth slightly longer and more prominent. Anterior femora four times as long as thick (60 : 15). Posterior tibia with the hairs arising at a sharp angle from its surface. Abdomen above less densely clothed with silvery pubescence, the naked spots as in *heidemanni.* Venter with the denuded spots not so large and conspicuous. Male clasper longer and slenderer than in related species (Plate II, fig. 3).

Brachypterous form: Pronotum slightly longer than broad (male, 36:39; female, 42:46), the anterior lobe arched. Scutellum small. Hemelytra extending to middle of second dorsal segment; the membrane very short, without distinct veins, somewhat sharply rounded behind. Length, 6.3–6.6 mm.; width, 1.2–1.3 mm. (at abdomen, 1.68–2.4 mm.).

Macropterous form: Pronotum broader than long (male, 54:48; female, 62:52), the fuscous markings of the posterior lobe tending to form a circle on disc. Hemelytra extending scarcely to the tip of the abdomen or far beyond it; the disc with a raised white spot at the distal end of the suture separating corium and embolium; the outer apical portion with a more or less distinct castaneous patch. Length, 6.6–8.1 mm.; width, 1.5–1.8 mm (at abdomen, 1.8–2.4 mm.).

This is the most common member of the subgenus *Hoplistoscelis*. Specimens have been examined from New York, Maine, Massachusetts, New Jersey, Pennsylvania, Ohio, Illinois, Wisconsin, Minnesota, Iowa, Nebraska, Missouri, Mississippi, Florida, Texas, Mexico, Guatemala, Panamá, Hayti, Cuba, and Grenada. The species varies in color from the typical sordid testaceous to a very light testaceous or even to flavo-testaceous. The antennal segments vary somewhat in length in specimens from various localities as also does the thickness of the anterior femora. In the development of the hemelytra there is also a great variation, specimens from Mexico, and Hayti have the membrane extending well beyond the apex of the abdomen while in other macropterous examples, from Iowa, it does not reach the apex of the abdomen. The short winged form is the much more common.

Biology. The writer has worked out the life history of *N. sordidus* as it occurs in the vicinity of Ames. The winter is spent in the adult stage, individuals hibernating beneath leaves, grasses, logs, and in other suitable places. These adults become active in early spring (mid-April) and the females are soon depositing eggs in the stems of plants. There is evidence to indicate that the females or at least some of them (also those of *N. roseipennis* Reut. (Plate I)) are fertilized in the fall previous to their entering into hibernation. The egg stage lasts for about two weeks. There are five nymphal instars. The total lapse of time from oviposition to transformation to adult, in the writer's experiments, varied from 33 to 37 days. The habits of the nymphs are in most ways similar to those of the other species of the genus. *Sordidus* frequents shady moist situations where the undergrowth is of a rank nature. It is often parasitized by a large red mite.

Nabis dentipes n. n.

1872. *Nabis crassipes,* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 83 (name preoccupied).
1873. *Coriscus crassipes* Stål, Enum. Hemip., III, p. 112.
1876. *Coriscus crassipes* Uhler, Bul. U. S. Geol. Surv., I, p. 325.
1890. *Nabis crassipes* Reuter, Rev. d'Ent., IX, p. 297.
1899. *Nabis crassipes* Champion, Biol. Centr. Am., Heter., II, p. 302, Tab. 18, figs. 22, 23, 24.

Oblong to ovate, pubescent; brownish to fusco-testaceous. the general markings as in other members of the subgenus. Head slightly broader than long. Eyes prominent, the length of one slightly less than width of vertex. Ocelli about equally as far apart as from the eyes. Antennae rather elongate, segment I thickened distally, its length distinctly less than width of head through eyes (30: 36); proportion, 30: 46: 42: (absent). Rostrum with segments I and II subequal, each slightly longer than antennal I. Scutellum with the usual pallid spot on either side. Hemelytra somewhat castaneous. Anterior and intermediate femora armed beneath as in other members of the subgenus, the teeth smaller than in *sordidus,* rather inconspicuous. Anterior femora rather strongly incrassate, not more than three times as long as deep (61: 21). Posterior tibia with its longest hairs about equal in length to its diameter, these hairs arising at an acute angle. Male smaller and less ovate than female, the genital segment very large, with distinctive clasper (Plate II, fig. 4).

Brachypterous form: (male). Pronotum slightly wider than long (65: 59), the anterior lobe arched. Hemelytra extending to middle of last abdominal segment, the membrane narrow, its length about twice that of claval commissure. Length, 7.2 mm.; width, 1.86 mm. (at abdomen, 2.7 mm.).

Macropterous form: (female). Pronotum much broader than long (72: 59). Hemelytra extending beyond abdominal apex; membrane about three times as long as claval commissure, its veins prominent, fuscous. Length, 7.8 mm.; width, 2.1 mm. (at abdomen, 2.85 mm.).

This species was originally described as *N. crassipes* from a brachypterous female from Mexico. Unfortunately, however, the name *crassipes* is preoccupied in the genus, having been used by Schrank in 1801, and now standing as a synonym of *N. ferus* Linn. The above description is taken from two specimens, male and female, from Cuernavaca, Morelos and Chilpancingo, Guerrero, Mexico, respectively. Both specimens were before Champion, who examined Reuter's type, when he made his notes on this species for the Biologia Centrali-Americana. Champion's artist failed to show the genital segments in his figure of the male. In both specimens before me the pronotum has a distinct inverted V-shaped fuscous design on the disc of the posterior lobe, the apex of the V being continuous with the median line of the anterior lobe. In the male the fuscous patches occupy much the greater part of the connexival segments. This species has been recorded, other than Mexico, from Georgia, Texas, and California. It seems to the writer that the Georgia record was undoubtedly made through a misidentification and that it probably should refer to *N. deceptivus* n. sp. described below. Nothing concerning the biology of the species is known.

Nabis nigriventris Stål.

1862. *Nabis nigriventris* Stål, Stet. Ent. Zeit., XXIII, p. 458.
1872. *Nabis sericans* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 83.
1873. *Coriscus nigriventris* Stål, Enum. Hemip., III, p. 114.
1890. *Nabis sericans* Reuter, Rev. d'Ent., IX, p. 296.
1899. *Nabis nigriventris* Champion, Biol. Centr. Amer., Heter., II, p. 302, Tab. XVIII, figs. 25, 25a.
1909. *Reduviolus nigriventris* Reuter, Mém. Soc. Ent. Belg., XV, p. 99.
1921. *Nabis nigriventris* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 2.

Similar to *N. dentipes* but smaller and less robust. Head equally as broad as long. Eyes large, the length of one equal to width of vertex. Ocelli equally as far from eyes as from each other. Antennae shorter than in any other member of the subgenus, segment I distinctly less than width of head through eyes (22: 29); proportional lengths of segments, 22: 39: 35: 35. Rostrum with segments II and III subequal, each distinctly longer than antennal I. Anterior and intermediate femora armed beneath as in other members of the subgenus, the teeth distinctly smaller and more inconspicuous than in *sordidus*. Anterior femora about $3\frac{1}{3}$ times as long as thick (50: 15). The posterior tibiae clothed as in *sordidus*. Venter with the denuded shiny patches at base of connexivum larger and more conspicuous than in *sordidus*. Male narrower than female, the clasper distinctive (Plate II, fig. 6).

Macropterous form: Pronotum broader than long (male, 58: 48; female, 63: 52), the fuscous markings of the posterior lobe tending to form a circle on the disc as in winged examples of *sordidus*. Hemelytra with a castaneous tinge throughout; membrane extending well beyond apex of abdomen, smoky, its veins fuscous and prominent. Length, 6.6–6.9 mm.; width, 1.6–1.74 mm. (at abdomen, 2–2.4 mm.).

The brachypterous form is unknown to me. In the types (brachypterous) the hemelytra were said to be slightly more than twice as long as the scutellum, broadly rounded at the apex, the membrane narrow and without veins. The above description is taken from a macropterous male and female from Quezaltenango and Cuernavaca, Mexico, respectively. They were before Champion when he examined the types of *nigriventris*, and its synonym *sericans* Reuter, for his notes on this species. *N. nigriventris* has been confused in collections with both *N. dentipes* and *N. sordidus*, but is distinctly smaller than the former and is more robust and darker in color than is the latter. Seven winged specimens are at hand, all from Mexico, excepting a male from Huachuca Mts., Arizona (July 13, 1905, H. G. Barber). This species is also recorded in the literature from Colorado, Texas, Guatemala, and St. Vincent. The records under this name from the eastern and southeastern states refer to the following closely related form, *N. deceptivus* n. sp.

Nabis deceptivus n. sp.

Similar to *N. nigriventris* Stål but larger, with longer antennae, rostrum, and legs, and differently constructed clasper of the male. Head slightly longer than broad. Eyes larger than in *nigriventris*, the length of one slightly more than width of vertex. Antennae with segment I less than width of head through eyes (26: 32); the proportional length of segments, 26: 45: 40: 38. Rostrum with segment II longer than I of antennae (33: 26). Pronotum broader than in *nigriventris*, the collar more sharply marked off in front. Anterior femora more than $3\frac{1}{3}$ times as long as deep (58: 16). Male with genital segment prominent, the clasper with a broad blade and bearing a distinct projection on the lower margin (Plate II, fig. 5).

Brachypterous form: Pronotum almost equally as long as broad (male, 47 : 49; female, 52 : 53). Hemelytra extending to middle of second dorsal abdominal segment; membrane minute, without veins. Length, 6.3–6.9 mm.; width, 1.32–1.62 mm. (at abdomen, 2.16–2.76 mm.).

Macropterous form: Pronotum distinctly broader than long (male, 63 : 56; female, 70 : 60), the anterior lobe feebly arched in front. Hemelytra extending well beyond tip of abdomen, with a distinct roseate tinge throughout. Length, 7.8 mm.; width, 2.1 mm. (at abdomen, 2.34–2.7 mm.).

Holotype, apterous male, Brownsville, Texas, Dec. 16, 1911. *Allotype,* apterous female, Prairie, Mississippi, July 27, 1921, C. J. Drake collector. *Morphotypes,* winged male, Knoxville, Tennessee, Feb. 27, 1892, and winged female, Texas. *Paratypes,* several brachypterous and macropterous males and females from following localities: Knoxville, Tenn., June 15, 1890, H. E. Summers; Gainesville, Florida, Aug. 7, 1918, C. J. Drake; Agr. College Miss., July 22, 1921, C. J. Drake; Olive Branch, Illinois, Sept. 5, 1923, Owen Bryant; Brownsville, Texas, Nov. 7, 1906, J. D. Mitchell; Chesapeake Beach, Maryland, O. Heidemann. Types in author's collection, paratypes in collection of U. S. Natl. Museum, Iowa State College, C. J. Drake and the author.

N. deceptivus is very closely related to *N. nigriventris* Stål and has been labelled under that name by the author and others in collections. The differences pointed out, however, are constant throughout the series of specimens at hand and there seems to be no reason to longer group the two forms together. The species may prove to be the form described from Texas by Reuter as *Nabis sericans,* but as Champion had a cotype of that before him when he compared Stål's type of *nigriventris* with the specimens described above as *nigriventris* it seems best to give this form a new name.

Nabis panamensis Harris.

1926. *Nabis panamensis* Harris, Proc. U. S. Natl. Mus., LXIX, Art. 21, p. 3.

Small, oblong, pubescent; testaceous, a median line on head and on pronotum (obsoletely), sides and humeri of pronotum, tip of scutellum, veins of hemelytra, basal segments of venter, segment I of rostrum, and subapical patch on femora embrowned. Head short; eyes large, coarsely granular, the length of one greater than width of vertex. Ocelli inconspicuous. Segment I of antennae greater than width of head through eyes (20: 16); proportion of segments, 20: 24: 20: (IV absent). Rostrum with segment II subequal to I of antennae; III distinctly shorter than II.

Pronotum broader than long (35: 31), the collar, sides and posterior lobe coarsely punctate, the anterior lobe rather strongly arched. Scutellum bifoveate on the disc, raised before the apex. Hemelytra constricted to opposite middle of clavus, ciliate along costal margin basally; the clavus and corium coarsely punctate along the veins at the base. Membrane extending well beyond the tip of abdomen. Legs moderately slender; anterior femora about 4½ times as long as thick (33: 7). Genital segments prominent; the clasper with long stem (Plate II, fig. 11). Length, 3.9–4.2 mm.; width, 1.02 mm. (at abdomen, 1.08–1.2 mm.).

This is the smallest *Nabis* occurring in our fauna. The above description is taken from the types, the species being known only from the type locality, Porto Bello, Panamá. *Panamensis* is here placed in the subgenus *Lasiomerus* Reuter even though it has certain pronounced differences from other members of the subgenus. Chief of these differences is the shorter postocular portion of the head, more arched anterior lobe of pronotum, punctate mesopleura, and differently constructed ostiolar canal. The short winged form is not known to occur.

Nabis spinicrus Reuter.

1890. *Nabis spinicrus* Reuter, Rev. d'Ent., IX, p. 305.
1894. *Coriscus signatus* Uhler, Proc. Zool. Soc. Lond., 1894, p. 205.
1899. *Nabis signatus* Champion, Biol. Centr. Am., Heter., II, pp. 302, 304, Tab. XVIII, figs. 31–33.
1908. *Reduviolus spinicrus* Reuter, Mém. Soc. Ent. Belg., XV, p. 103.

Slender, elongate, pilose; testaceous, the sides of head and also a median line thereon, a pattern on anterior lobe of pronotum, five longitudinal stripes on the posterior lobe, disc of scutellum, sides of thorax, and a submarginal stripe on each side of venter infuscated. Antennae with an apical ring on segment II and all of III and IV fuscous. Legs pale, with a subapical ring on femora, and a ring before the base and another at the apex of tibiae brown. Connexivum often with the basal angles of its segments embrowned. Head long, much longer than broad, the postocular part parallel-sided. Eyes prominent, the length of one subequal to width of vertex. Antennae long, segment I much longer than width of head through eyes (42 : 24) ; proportion of segments, 42 : 57 : 63 : 55. Rostrum long, segments II and III subequal, each about $\frac{1}{4}$ shorter than antennal I. Pronotum with the collar, sides, and posterior lobe finely punctate. Legs slender, anterior femora about seven times as long as thick, provided on the sides below with a row of dark spots from each of which arises a long, tapering, spine-like seta; intermediate femora also with a row of spine-like setae on the posterior margin below; posterior tibiae finely pubescent and also beset with numerous very long rigid hairs. Male with genital segment prominent; the clasper hook-like (Plate II, fig. 7).

Brachypterous form: Ocelli very indistinct. Pronotum distinctly longer than broad (36: 22). Hemelytra extending to base of first abdominal segment, sharply rounded and divaricating apically, without trace of membrane. Length, 6.3–6.7 mm.; width, .67–.79 mm. (at abdomen, .84–1.08 mm.).

Macropterous form: Ocelli prominent. Pronotum about as broad as long (40: 39). Hemelytra extending slightly beyond apex of abdomen, the inner and outer apical angles, an elongate spot on commissure and another on corium opposite the commissure infuscated; membrane with veins prominent, extending to margin without forming closed cells. Length, 6.3–7.4 mm.; width, 1.14–1.32 mm. (at abdomen, 1.02–1.32 mm.).

Spinicrus is readily separated from our other known American nabids by the spine-like setae on the anterior and intermediate femora. In the females the spines are also present on the anterior tibiae, two rows of them, five spines in the row on the anterior surface and four in that of posterior surface. The fuscous markings are often more or less obsolete. The hemelytra are constricted before the middle and are ciliate on the costal margin towards the base. The shorter hairs clothing the anterior tibiae and the anterior femora beneath are distinctly hooked in character. In addition to the shorter hairs on the lower surface of the anterior and intermediate femora there are also numerous minute, piceous spinules. Specimens have been seen from Panamá, Guatemala, British Guiana, Grenada, St. Vincent, Hayti, Cuba, and Florida. The Florida specimens are lighter in color with the darker markings more pronounced than in other specimens, also their appendages are slightly shorter. *Spinicrus* is also recorded from Mexico, Brazil and Perú. The record of Bueno from Brownsville, Texas (Ent. News, XXIII, p. 126, 1912) must stand as questionable as a specimen from that locality labelled in his collection *N. signatus* Uhler is a typical *N. capsiformis* Germar. Cotypes of *signatus* are before me. Blatchley records the capture of specimens by sifting plant debris from the margin of a pond, while Uhler records his specimen as taken from open weedy places near a stream.

Nabis annulatus Reuter.

1872. *Nabis annulatus* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 86, Pl. VIII, fig. 4.
1873. *Coriscus annulatus* Stål, Enum. Hemip., III, p. 112.
1890. *Nabis annulatus* Reuter, Rev. d'Ent., IX, p. 305.
1921. *Nabis annulatus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 5.

Moderately large, oblong; pilose; flavo-testaceous to testaceous, with the brown to fuscous markings as in *spinicrus* but more pronounced, often with crimson patches on the sides of the scutellum, the subapical part of the corium, the outer apical angle of the third connexival segment above, and along the sides of the venter. Head longer than broad, the postocular part parallel-sided. Eyes large, the length of one subequal to width of vertex. Ocelli prominent, placed about equally as far from eyes as from each other. Segment I of antennae much longer than width of head through eyes (48: 27); proportion of segments, 48: 76: 69: 55. Rostrum with segments II and III subequal, each much shorter than antennal I (38: 48).

Pronotum broader than long (male, 57: 48; female, 69: 56), the collar, sides, and posterior lobe coarsely punctate; scutellum impressed on the disc. Hemelytra ciliate on the costal margin toward the base, constricted to a point opposite middle of commissure; the membrane extending beyond apex of abdomen, with three elongate closed cells. Legs rather long, anterior and intermediate femora provided beneath with numerous minute, piceous spinules which are more or less obscured by the thick clothing of longer hooked hairs; anterior femora about six times as long as thick; posterior tibia clothed with short outwardly slanting pubescence and with numerous much longer almost erect, fine hairs. Segments of venter with small denuded shiny spots on each side at the base of connexivum. Male genital segments long, the clasper with a hook-like blade (Plate II, fig. 8). Length, 8.04–9.18 mm.; width, 1.68–1.98 mm. (at abdomen, 1.98–2.52 mm.).

Annulatus was originally described from Illinois and is now known to occur throughout the eastern portion of the United States. Specimens have been examined by the author from Ontario, New York, New Jersey, Massachusetts, Pennsylvania, Ohio, Indiana, Illinois, Minnesota, Iowa, Mississippi, Missouri, and North Carolina. Examples from more southern localities are lighter in color with more pronounced crimson markings than those from farther north. The antennal segments vary slightly in length. The species is most closely related to the following, *N. constrictus* Champ., from which it may be separated by its larger size and the shape of the clasper. The mesosternum is longitudinally sulcate as in all (?) other members of the genus. The spine-like setae on the legs of the related *N. spinicrus* are represented in *annulatus* by slender hairs.

Biology: *N. annulatus* is to be found inhabiting shady woods where the undergrowth is rather rank. The species is a rapid-flying one and a collector who would take it must be ever on the alert as he opens his net to examine the contents. *Annulatus* apparently overwinters in the egg stage. The nymphs and adults, like those of other species frequenting shady moist situations (*sordidus* and *roseipennis*), are often parasitized by a large red mite. The adult males spend a great portion of their time in the act of stridulation. During the writer's field observations he once observed an individual so occupied. The beating or stroking of the tibia was halted at intervals. After a few moments another individual appeared on the plant adjacent to the one upon which the male was perched. It was a female and she slowly advanced in the direction of the stridulating male, her every movement, so far as the writer was able to judge, giving the impression of awareness of the male. When she had gained the same plant as that upon which the male was stationed that individual utilized the intervals between his acts of stridulating to move forward a few steps. Finally the two stood upon the same leaf. The male ceased his stridulating and stood slowly moving his antennae. Suddenly there was a quick movement and he had seized the female and was trying to effect accouplement. The writer has judged from this and other observations that the stridulating of the male must produce some sound that is perceptible to the female.

Nabis constrictus Champion.

1900. *Nabis constrictus* Champion, Biol. Centr. Am., Heter., II, p. 303, Tab. XVIII, figs. 29, 30.
1908. *Reduviolus constrictus* Reuter, Mém. Soc. Ent. Belg., XV, p. 103.
1916. *Nabis constrictus* Barber, Jour. N. Y. Ent. Soc., XXIV, 4, p. 308.

Very similar to *annulatus* but distinctly smaller, with shorter appendages, and differently constructed male clasper; the crimson markings of hemelytra usually present as a prominent line along apical margin of corium and an interrupted submarginal stripe extending for almost the entire costal length. Segment I of antennae longer than width of head through eyes (35: 24); the segments in proportion, 35: 53: 50: 48. Rostral segments II and III subequal, each shorter than antennal I (31: 35). Pronotum broader than long (male, 48: 40; female, 51: 43). Legs as in *annulatus,* but shorter. Male clasper distinctive (Plate II, fig. 9). Length, 6.6–7.5 mm.; width, 1.38–1.56 mm. (at abdomen, 1.74–1.98 mm.).

This pretty little species is very closely related to *N. annulatus.* It was described from Mexico, Guatemala, and Panamá and has since been recorded from District of Columbia and Florida. The author has seen specimens from Guatemala, Honduras, Mexico, Florida, Maryland, District of Columbia, and Virginia. The crimson markings of the hemelytra are often obsolete as also are the fuscous patches on the connexival segments. The brachypterous form, as in *annulatus,* is unknown. Nothing is known of the biology. Blatchley records the capture of two specimens by beating bunches of Spanish moss near the margin of a Florida lake.

Nabis propinquus Reuter.

1872. *Nabis propinquus* Reuter, Öf. Vet. Akad. Förh., XXIX, p. 87.
1872. *Nabis vicarius* Reuter, Öf. Vet. Akad. Förh., XXIX, p. 87, pl. 8, fig. 6.
1873. *Coriscus propinquus* Stål, Enum. Hemip., III, p. 113.
1890. *Nabis propinquus* Reuter, Rev. d'Ent., IX, p. 308.
1907. *Nabis elongatus* Hart, Bull. Ill. St. Lab. Nat. Hist., VII, p. 262.
1908. *Reduviolus propinquus* Reuter, Mém. Soc. Ent. Belg., XV, p. 105.

1921. *Nabis propinquus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 6.

Slender, greatly elongate, pubescent; testaceous, an interrupted median line extending from base of tylus to tip of abdomen and a broad stripe on either side of body for its full length fuscous. Femora fusco-maculate. Head long, more than a third longer than broad, faintly widened behind the eyes. Eyes only moderately large, the length of one equal to width of vertex (14). Ocelli prominent. Antennae long, darkened distally, segment I much longer than width of head through eyes (52 : 31); proportion of segments, 52 : 82 : 76 : 63. Rostrum with segments II and III subequal, each much shorter than I of antennae (36 : 52).

Pronotum with long collar, the anterior lobe with the cicatrices darkened; the posterior lobe finely punctulate. Scutellum with a prominent, semicircular, shiny spot on either side basally. Abdomen above with an interrupted fuscous stripe to either side of the median dark line; the connexivum horizontal. Legs long, the anterior and intermediate femora thickly clothed beneath with short hooked hairs and more thinly so with shorter piceous spinules; anterior femora about six times as long as thick; posterior tibiae clothed with short hairs. Male narrower than female, the genital segments long, prominent, the clasper distinctive (Plate III, fig. 1). Female with abdomen rather sharply angular at apex, the apical margin of last abdominal segment emarginate.

Brachypterous form: Pronotum longer than broad (male, 48 : 45; female, 55 : 52), the lobes indistinctly marked off, the basal margin roundly emarginate (more strongly so in male). Hemelytra extending almost to apex of second abdominal segment, obtusely rounded behind, without membrane. Length, 9–12 mm.; width, 1.32–1.68 mm. (at abdomen, 1.32–2.82 mm.).

Macropterous form: Pronotum broader than long (female, 71: 58), the posterior lobe arched. Hemelytra somewhat translucent, finely punctulate; membrane extending onto base of last abdominal segment. Length, 12 mm.; width, 2.1 mm.

N. propinquus is the longest of the American Nabids and is easily recognized by its form. It is closely related to the Palaearctic *N. lineatus* Dahlb. The species was originally described from Wisconsin and has since been recorded from Illinois, Ohio, New York and Ontario. The author has seen specimens from all of these regions and in addition from Iowa, Massachusetts, and Alberta. The abdominal tergites have, as in almost all other species of *Nabis*, a distinct transverse shiny spot on each side. Macropterous examples are extremely rare, the male perhaps never occurring in this form. The antennal segments, and other portions of the body vary slightly here as in other members of the genus. The segments of the abdomen are usually about one-half as long as broad. This species frequents the edges of marshes and ponds where the reeds and sedges flourish. The writer has taken it in such situations in company with *Protenor belfragei* Haglund.

Nabis limbatus Dahlbom.

1850. *Nabis limbatus* Dahlbom, Konig. Vet. Akad. Handl., p. 227.

1872. *Nabis limbatus* Reuter, Öf. Vet. Akad. Förh., XXIX, pp. 70, 87, pl. VIII, fig. 5.

1908. *Reduviolus limbatus* Reuter, Mém. Soc. Ent. Belg., XV, p. 107.

1921. *Nabis limbatus* Hickman, Bul. Brookl. Ent. Soc., XVI., p. 58, fig. 7.

1922. *Nabis limbatus* Drake, N. Y. St. Coll. For., Tech. Pub. 16, p. 68, fig. 27a.

Similar to *N. propinquus* but distinctly less elongate, the fuscous markings usually more pronounced, sometimes the three stripes on the abdomen irregularly united to form one broad longitudinal stripe. Head moderately long, only about one-eighth longer than broad. Eyes slightly larger and more prominent than in *propinquus*, the length of one equal to width of vertex. Ocelli conspicuous. Antennae rather long, segment I distinctly longer than width of head through eyes (41: 32); proportion, 41: 71: 63: 48. Rostrum with segments II and III subequal (35: 33), each much shorter than I of antennae.

Pronotum with the pattern on anterior lobe more distinct than in *propinquus*, often in greater part fuscous; posterior lobe finely punctulate. Legs about as in *propinquus* but less elongate; the anterior femora about $5\frac{1}{2}$ times as long as thick. Connexivum horizontal. Male slenderer than female, the sides almost parallel; the clasper (seen from above) bowed or cupped outward from body (Plate III, fig. 5). Female with abdomen widened at the middle, the apex pointed, but shorter and more obtusely so than in *propinquus*.

Brachypterous form: Pronotum with the sides slightly constricted, thus delimiting the lobes, slightly broader than long (male, 46 : 45; female, 48 : 46), the basal margin rather truncate or broadly emarginate. Hemelytra translucent, indistinctly fine punctulate, extending onto second abdominal tergite, broadly obtusely rounded or truncate apically, with only faint evidence of membrane. Length, 7.62–9 mm.; width, 1.2–1.5 mm. (at abdomen, 1.6–3 mm.).

Macropterous form: Pronotum broader than long (male, 59 : 50; female, 65 : 53), the anterior lobe sometimes almost entirely black, the posterior lobe arched, truncate behind. Hemelytra extending to tip of abdomen, the coriaceous part finely punctulate, sometimes infuscate; membrane with the usual three elongate cells. Length, 8.4–9 mm.; width, 1.68–1.98 mm.

N. limbatus is an European species and was first definitely recorded from America by Reuter who examined specimens from Colorado and Canada. The Colorado records however undoubtedly pertain to the following very closely related species. The writer has seen specimens of *limbatus* from Alberta, Maine, New York, and Minnesota. These differ in no appreciable way from numerous European examples at hand. The macropterous form is quite rare, the male not having heretofore been known to occur with developed wings. The Minnesota specimens before me (all females) have thicker anterior femora than do the eastern specimens, in this respect agreeing very well with the following species. Also it is to be noted that the antennae and other characters in which measurements are given in the description above are subject to slight variations. The abdominal segments, excepting the last, are scarcely more than a fourth as long as broad. The species inhabits vegetation in and around bogs and marshes.

Nabis nigro-vittatus Sahlberg.

1878. *Nabis nigro-vittatus* J. Sahlberg, K. Sv. Vet. Akad. Handl., XVI, pp. 36, 162.

1908. *Reduviolus nigro-vittatus* Reuter, Mém. Soc. Ent. Belg., XV, p. 106.

Form, size, and color very similar to *N. limbatus*, head slightly narrower, the eyes smaller. Antennae with segment I distinctly longer than width of head through eyes (40 : 31); formula, 40 : 66 : 55 : 37). Rostrum with segments II and III subequal (31 : 31). Pronotum finely punctulate on the posterior lobe. Anterior femora slightly more incrassate than in *limbatus,* scarcely more than four times as long as thick. Male with prominent genital segments, the clasper as viewed from above straight, produced forward in one plane, not bowed or cupped outward at the middle as in *limbatus* (Plate III, fig. 3).

Brachypterous form: Pronotum as broad as long (male, 45 : 45; female, 50 : 50), constricted as in *limbatus.* Hemelytra translucent, extending to middle of third abdominal segment, rather sharply rounded apically, the membrane very short, pointed. Length, 7.38–8.6 mm.; width, 1.32–1.5 mm. (at abdomen, 1.8–2.8 mm.).

N. nigro-vittatus, a Siberian species, has heretofore not been recognized as occurring in the United States. The above description is taken from a series of specimens from Pingree Park and Estes Park, Colorado. These agree in all essentials with European specimens before me, though the first antennal segment is slightly shorter. The color markings, as in *limbatus,* vary in their degree of prominence but most often are distinctly darker than in that species. The records of *N. limbatus* from Colorado undoubtedly pertain to this species as it has until now been labelled under that name in collections. The macropterous form (unknown to me) is said to have the membrane extending beyond the apex of the abdomen. The median line on the abdomen and a sub-basal one on the connexivum are sometimes more or less crimson. The head is in none of the specimens before me ''hinter den Augen sehr deutlich langer als der des *R. limbatus*'' as Reuter has described it.

Nabis gerhardi Harris

1928. *Nabis gerhardi* Harris, Bul. Brookl. Ent. Soc., XXIII, p. 146.

Body short, broad, opaque, pilose; testaceous, marked with fuscous to black. Head with the tylus, a broad stripe on the vertex (widened anteriorly), and the sides behind the eyes brownish fuscous, its under surface black. Pronotum with anterior lobe and the sides in greater part brown, the cicatrices and a median line fuscous; the posterior lobe with humeri and five obsolete lines on the disc brown. Scutellum black with a yellowish callosity on either side. Hemelytra obsoletely mottled or speckled with brown, darker apically. Connexivum pale testaceous, the basal halves of the segments dark brown to fuscous. Meso- and metasternum dull black.

Venter brown, paler distally. Antennae, rostrum, and legs brownish testaceous, the latter spotted with brown.

Head short, broader than long, slightly obliquely narrowed behind the eyes. Eyes moderately large, the length of one distinctly less than width of vertex. Ocelli raised, very prominent. Antennae short, segment I less than half the width of head through eyes (16: 33); proportion of segments, 16: 28: 25: 24. Rostrum with segments II and III subequal, each slightly longer than I of antennae (21: 16). Pronotum broader than long (62: 59). Hemelytra moderately thickly clothed with short, semi-erect brownish hairs; membrane hyaline, extending beyond apex of abdomen. Legs short, rather thickly pilose; the anterior femora incrassate, only about three times as long (measured beneath) as deep. Intermediate femora armed beneath with numerous short, piceous spinules. Venter thickly clothed with fine, silvery hairs. Genital segment short; the clasper with a broad semicircular blade (Plate II, fig. 10). Length, 5.8 mm.; width, 1.85 mm. (at abdomen, 2.25 mm.).

This distinct little species is the most robust of our members of the genus and is readily recognizable by its short antennae, maculate connexivum, and robust form. It is known only by the holotype, from Tepehuanes, Mexico, which is the specimen listed by Blatchley (Heteroptera Eastern North America, p. 594) as *N. crassipes* Reuter (= *N. dentipes* n.n.). The femora however lack the characteristic armature of *dentipes* and its more closely related allies which belong to the subgenus *Hoplistoscelis* while *gerhardi* apparently belongs to subgenus *Nabis*.

Nabis flavomarginatus Scholtz.

1846. *Nabis flavomarginatus* Scholtz, Arb. Schles. Ges. Vat. Kultur., p. 114.
1850. *Nabis dorsatus* Dahlbom, Konig. Vet. Akad. Handl., 1850, p. 227.
1852. *Nabis nervosus* Boheman, Öf. Vet. Akad. Förh., IX, p. 77.
1856. *Nabis thesigus* Kolenati, Melet. Ent., IV, p. 258.
1861. *Nabis flavomarginatus* Fieber, Europ. Hemip., p. 161.
1872. *Nabis flavomarginatus* Reuter, Öf. Vet. Akad. Förh., XXIX, pp. 71, 78, Pl. 8, fig. 7.
1908. *Reduviolus flavomarginatus* Reuter, Mém. Soc. Ent. Belg., XV, p. 111.

1921. *Nabis flavomarginatus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 8.

Oblong to oblong-ovate, pilose; pale testaceous, a median stripe above and the sides of head, three broad stripes on anterior lobe of pronotum and a median stripe on posterior lobe, the abdomen above (except for a median line), and meso- and metasternum black. The cicatrices on anterior lobe of pronotum, two somewhat obsolete lines on posterior lobe, a broad stripe on either side and a narrow median line on venter, and numerous maculae on legs brownish fuscous to black. Head equally as broad as long, the transverse depressed line on vertex somewhat prominent; postocular part rather short, distinctly narrowed backwards. Eyes large, prominent, the length of one slightly greater than width of vertex (17:16). Ocelli distinct, equally as distant from the eyes as from each other. Antennae moderately long, segment I slightly longer than width of head through eyes (42:40); proportion of segments, 42:70:58:48. Rostrum with segments II and III subequal, each about equally as long as I of antennae.

Pronotum with a long collar; the posterior lobe finely punctulate. Scutellum with a distinct semicircular shiny spot in each basal angle and with a raised yellowish callosity on either side. Hemelytra finely punctulate, sparsely clothed with fine short hairs. Legs moderately long; anterior femora thickest near the base, about 3½ times as long as deep (77:22); intermediate femora armed beneath with minute, piceous spinules. Abdomen above and beneath thickly clothed with silvery, sericeous hairs. Male narrower and more elongate than female, with prominent genital segment; the clasper with short rectangular stem and blade, the blade with a distinct spur on its upper edge near the base (Plate III, fig. 2).

Brachypterous form: Pronotum broader than long (male, 60:53; female, 63:56), the anterior lobe rather highly arched, the collar sharply marked off. Hemelytra obliquely narrowed backwards, extending to about the base of the fifth abdominal segment, the membrane narrow. Length, 7.8–9 mm.; width, 1.75–1.92 mm. (at abdomen, 2.28–3.3 mm.).

Macropterous form: Pronotum much broader than long (75:58). Scutellum larger, the basal shiny spots less conspicuous, the base more arched. Hemelytra somewhat speckled with fuscous, the veins paler, prominent; membrane extending beyond apex of abdomen. Length, 9.3 mm.; width, 2.32 mm. (at abdomen, 3.3 mm.).

Flavomarginatus is a Palaearctic species common in the northern part of Europe. It is remarkable for its pterygopolymorphism, Reuter having distinguished at least six distinct forms based on wing development. The species varies somewhat in color, the fuscous or black margins often being very pronounced; also the antennae vary considerable in length. Two winged examples (from Europe) before me have the antennal formula, 36 : 60 : 56 : 35, while all other specimens (apterous), from America and Europe, show very little variation. The hemelytra are without the usual three brown spots so common to our other members of the subgenus *Nabis*. The author feels that this and the following species, *N. vanduzeei* Kirk., may prove to be more closely related to *N. subcoleoptratus* Kirby (subgenus *Nabicula*) than to the members of the subgenus *Nabis*. The winged male is unknown to me. Specimens have been examined from Kussiloff, Alaska (July, 1898, W. H. Evans), Slave Lake, Alberta (Aug. 17, 1924, O. Bryant) and from numerous European localities. The Colorado records in the literature refer to the following species.

Nabis vanduzeei (Kirkaldy).

1901. *Reduviolus vanduzeei* Kirkaldy, Wien. Ent. Zeit., XX, p. 223.

1908. *Reduviolus flavomarginatus vanduzeei* Reuter, Mém. Soc. Ent. Belg., XV, p. 111.

1926. *Nabis vanduzeei* Harris, Ent. News, XXXVII, p. 287.

Similar to *N. flavomarginatus* but slightly shorter, more ovate; paler in color, the markings on head and pronotum brown to brownish fuscous, never black; the clasper differently constructed.

Head equally as long as broad, the postocular part slightly longer and more obliquely narrowed than in *flavomarginatus*. Antennae with length of segment I slightly less than width of head through eyes (37 : 40); proportional lengths of segments, 37 :70 : 60 : 40. Rostrum with segments II and III subequal, each equally as long as I of antennae. Legs moderately long, the anterior pair about 4 times as long as thick. Venter broader than in *flavomarginatus*. Male clasper slightly shorter and broader than in that species, the stem without the backward projecting spur near its base (Plate III, fig. 7).

Brachypterous form: Pronotum slightly broader than long (male, 55 : 53; female, 60 : 57), the collar slightly shorter and less sharply marked off than in *flavomarginatus*. Hemeyltra extending only to about middle of third abdominal segment. Length, 7.68–8.5 mm.; width, 1.62–1.86 mm. (at abdomen, 2.58–3.4 mm.).

Macropterous form: Color in greater part pale yellowish testaceous. Pronotum much broader than long (female, 77 : 58). Hemelytra narrowed from before the middle as in *flavomarginatus* and without the usual three discal brownish spots; membrane extending beyond apex of abdomen. Length, 9.3 mm.; width, 2.22 mm. (at abdomen, 3.48 mm.).

This form, although closely related to the preceding, should be, as previously pointed out by the writer, accorded specific rank. It is known only from Colorado and Montana. Kirkaldy's type, a brachypterous female, is before me. The male is not known to occur in the macropterous form.

Nabis lovetti Harris.

1925. *Nabis lovetti* Harris, Ent. News, XXXVI, p. 205.

Oblong-ovate, opaque, pilose and sparsely pubescent; yellowish brown, marked with fuscous. A median stripe on head and anterior lobe of pronotum, and meso- and metasternum black. Lateral and ventral stripes on head, markings on anterior lobe of pronotum, seven (sometimes obsoletely developed) stripes on posterior lobe of pronotum, disc of scutellum, three discal spots on each hemelytron, abdomen above in greater part, lateral stripe on either side of body, median stripe of venter, maculae of legs, and apex of second antennal segment brown to fuscous.

Head slightly longer than broad, the postocular part short, slightly narrowed behind. Eyes only moderately large, the length of one slightly less than width of vertex. Ocelli prominent, placed closer to eyes than to each other. Antennae rather short, the apical segments fuscous, segment I less than width of head through eyes (28 : 34); proportional lengths of segments, 28 : 43 : 39 : 35. Rostrum darkened distally, segments II and III subequal in length, each slightly longer than antennal I.

Pronotum with rather wide collar, sparsely pubescent. Scutellum depressed on the disc, the lateral margins yellowish. Hemelytra opaque, rather thickly and evenly clothed with short golden pubescence. Legs moderately short, spotted with fuscous to brown; the anterior femora clothed beneath with numerous short hairs and minute piceous spinules, about 3½ times as long as thick; intermediate femora clothed as anterior. Male with long genital segment, the clasper slender and lancelike (Plate II, fig. 12).

Brachypterous form: Pronotum broader than long (63:53), the anterior lobe arched. Hemelytra narrowed posteriorly; membrane well developed, extending to middle of genital segment, veins distinct. Length, 7–7.5 mm.; width, 1.92 mm. (at abdomen, 2.58 mm.).

Macropterous form: Pronotum much broader than long (female, 75:57). Hemelytra entire; the membrane extending well beyond apex of abdomen, with three elongate, closed, discal cells. Length, 8.82 mm.; width, 2.28 mm. (at abdomen, 2.88 mm.).

This remarkably distinct species is to be separated from all other American nabids by the yellowish to reddish brown color, which has somewhat of an orange to roseous tinge, by the nature of the pubescence of the hemelytra, and especially by the linear, lance-like clasper of the male. It was described from California and Oregon and is known only from the type localities.

Nabis roseipennis Reuter (Plate I).

1872. *Nabis roseipennis* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 89, Pl. VIII, fig. 10.
1872. *Nabis punctipes* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 89, Pl. VIII, fig. 11.
1873. *Coriscus roseipennis* Stål, Enum. Hemip., III, p. 113.
1873. *Coriscus punctipes* Stål, Enum. Hemip., III, p. 113.
1890. *Nabis roseipennis* Reuter, Rev. d'Ent., IX, p. 308.
1908. *Reduviolus roseipennis* Reuter, Mém. Soc. Ent. Belg., XV, p. 118.
1921. *Nabis roseipennis* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 11.
1922. *Nabis roseipennis* Mundinger, N. Y. State Coll. For., Tech. Publ. 16, pp. 151–160, figs. 22, 29, 32.

Oblong, opaque, thinly pilose; yellowish to brownish testaceous, thickly marked with brownish fuscous to black. Head with median line above, lateral stripes, and lower surface dull black. A median line on anterior lobe of pronotum, scutellum in greater part, a broad stripe on each side of body, meso- and metasternum, and median line of venter dark brown to black.

Head distinctly longer than broad. Eyes prominent, the length of one subequal to width of vertex. Ocelli conspicuous, slightly closer to each other than to the eyes. Antennae testaceous, an apical ring on segment II and all of III and IV fuscous to black; segment I subequal to (brachypterous, 31: 31) or longer (macropterous, 38: 31) than width of head through eyes. Rostrum with segment II and III subequal, each equal to or slightly shorter than antennal I. Pronotum sparsely pubescent, the cicatrices of anterior lobe brown. Scutellum depressed on disc, the lateral callosities (often extending to apex) yellowish. Hemelytra sparsely pubescent, thickly speckled or spotted with brown or fuscous, the veins paler, raised, prominent. Legs spotted with fuscous to brown, the spots on sides of anterior and intermediate femora tending to a transverse striping; tibiae dotted with brown; anterior femora about 4 (brachypterous) to $4\frac{2}{3}$ (macropterous) times as long as deep. Male with long genital segment which has an outward projecting flange or flap upon which the blade of the clasper rests; the clasper with long somewhat sinuate stem (Plate III, fig. 6).

Brachypterous form: Antennal formula, 31: 48: 48: 38. Pronotum broader than long (male, 48: 43; female, 55: 47), the posterior lobe not more strongly arched than anterior. Hemelytra extending to tip of abdomen; the membrane narrow, with closed discal cells. Anterior femora slightly shorter and more incrassate than in macropterous form. Length, 6.6–7.6 mm.; width, 1.44–1.68 mm. (at abdomen, 2.11–2.6 mm.).

Macropterous form: Antennal formula, 38: 64: 63: 47. Pronotum much broader than long (male, 60: 47; female, 65: 52), the posterior lobe much higher than anterior lobe. Hemelytra entire, extending well beyond apex of abdomen. Length, 8.4–9.2 mm.; width, 1.68–2 mm. (at abdomen, 2–2.6 mm.).

Roseipennis is one of the more common and better known nabids. It is at once distinguishable from all of our other members of the genus by the sinuate stem of the clasper and the projecting flange on each side of the genital segment of the male, the larger size, darker brown color, and the dotted tibiae. The brachypterous form is the more common one in higher altitudes and more northern regions, while further south only macropterous individuals seem to occur. The color is somewhat variable, occasionally in short-winged specimens tending to a yellowish testaceous with a roseous tinge. The connexivum is often marked with crimson. The species was originally described from Wisconsin and New Jersey. The author has examined specimens from the following localities: Ontario, Quebec, New York, Massachusetts, New Jersey, Pennsylvania, Ohio, West Virginia, Virginia, North Carolina, Tennessee, Alabama, Florida, Mississippi, Missouri, Illinois, Indiana, Michigan, Wisconsin, Iowa, Minnesota, Nebraska, Kansas, Colorado, Alberta, and British Columbia.

Biology: Mundinger (1922) has published a rather complete study of the life and habits of *N. roseipennis*. At Ames the duration of the various stages is considerably shorter than that recorded by Mundinger for them in New York. The species hibernates in the adult stage. Eggs are deposited in the stems of plants and the life habits are quite similar to those of other members of the genus. The adults seem to prefer more shady situations than does *N. ferus* Linn., though they are common in grassy meadows and along the margins of woods. The writer has observed no indication of a tendency for a gravid female to return to a previously selected spot for oviposition as Mundinger found to be the case in New York.

Nabis rufusculus Reuter.

1872. *Nabis rufusculus* Reuter, Öf. Vet. Akad. Förh., XXIX, p. 92.
1873. *Coriscus rufusculus* Stål, Enum. Hemip., III, p. 113.
1878. *Coriscus assimilis* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, p. 422.
1901. *Reduviolus cherokeanus* Kirkaldy, Wien. Ent. Zeit., XX, p. 224.
1908. *Reduviolus rufusculus* Reuter, Mém. Soc. Ent. Belg., XV, p. 119.
1921. *Nabis rufusculus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 58, fig. 12.
1922. *Nabis rufusculus* Mundinger, N. Y. St. Coll. For., Tech. Pub. 16, p. 149, pls. 12–19.

Similar to *roseipennis* but slightly smaller, the color distinctly paler; the markings most often brownish, sometimes with a crimson tinge, rarely black; the first antennal segment slenderer, the eyes slightly smaller, the posterior tibiae usually immaculate, and the clasper of the male with short stem and very broad semicircular blade.

Head longer than broad. Eyes prominent, slightly smaller than in *roseipennis*. Antennae with segment I longer than width of head through eyes (34 : 29) ; proportion of segments, 34 : 53 : 50 : 37. Rostrum with segments II and III subequal to each other and to I of antennae. Pronotum with the median line crimson to brownish, the cicatrices of anterior lobe and the lateral lines of posterior lobe usually only slightly darkened. Scutellum in greater part pale testaceous, the median line crimson to fuscous. Hemelytra usually distinctly less maculate and splotched with brown than in *roseipennis.* Legs feebly spotted with fuscous, the posterior tibiae usually immaculate; anterior femora 4 times as long as deep. Male smaller and less ovate than female, the clasper with short stem and broad semicircular blade (Plate III, fig. 8).

Brachypterous form : Pronotum broader than long (male, 42: 38; female, 52: 49) ; the anterior lobe rather strongly arched, the collar well marked off. Hemelytra somewhat arched; the membrane extending scarcely to or slightly beyond tip of abdomen, usually without closed cells. Length, 6.4–6.9 mm.; width, 1.3–1.6 mm. (at abdomen, 1.8–2.6 mm.).

Macropterous form: Color usually darker, more brownish than in brachypterous. Pronotum broader than long (52: 49) ; the posterior lobe much higher than anterior lobe. Hemelytra extending well beyond apex of abdomen; the veins distinct, forming the usual elongate closed cells. Length, 7.2 mm.; width, 1.5 mm. (at abdomen, 2.3 mm.).

This species usually is easily recognized by its pale, reddish yellow color. At times, however, the brachypterous females are extremely difficult to separate from those of *N. roseipennis.* The posterior tibiae, usually immaculate, may at times have a row of fine fuscous dots, from each of which a strong seta arises. Only one specimen of those that I have examined has had closed cells in the membrane of the brachypterous form. This one, a female from Oregon, is fully as large as the brachypterous *roseipennis.* One specimen before me has the left hemelytron reaching almost to the apex of the abdomen while the right extends not much beyond the middle of the abdomen. *Rufusculus* was described from a short-winged female from Wisconsin. Specimens are before me or have been examined by me from the following states: Ontario, Maine, Massachusetts, New York, Pennsylvania, West Virginia, North Carolina, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, Idaho, Oregon, Washington, British Columbia, and Alberta. The species is also recorded from Maryland, District of Columbia, Virginia and Colorado. The type of *Nabis cherokeanus*

Kirkaldy, a macropterous male from North Carolina, is before me. It undoubtedly is referable to *N. rufusculus* but has slightly smaller legs and narrower clasper. The life stages and habits are very similar to those of *N. roseipennis.*

Nabis kalmii Reuter.

1872. *Nabis kalmii* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 91, Pl. VIII, fig. 15.
1873. *Coriscus kalmii* Stål, Enum. Hemip., III, p. 113.
1901. *Reduviolus kalmii* Kirkaldy, Wien. Ent. Zeit., XX, p. 225.

Similar to *N. rufusculus* from which it differs in its more testaceous color, slenderer and straighter first antennal, slightly narrower head, and narrower clasper of male (Plate III, fig. 9). Length, 6.3–7.3 mm.; width, 1.3–1.65 mm. (at abdomen, 1.6–2.1 mm.).

This little understood species is extremely closely related to *N. rufusculus* Reuter, differing from that form only in the characters pointed out above. It is more southern in distribution and only the macropterous form is known to occur. Specimens are at hand from Wisconsin, Illinois, Ohio, District of Columbia, Virginia, Alabama, Missouri, Iowa, and Kansas. It is listed in the literature as also occurring in Nebraska and Colorado. A male specimen determined by Reuter is before me. In the opinion of the author *N. kalmii* may prove upon further study to be no more than the macropterous form of *N. rufusculus.* Unfortunately, the only long-winged male of this latter species before me is Kirkaldy's type of *N. cherokeanus* and that, as is pointed out above, has the clasper slightly narrower than the brachypterous form. Further evidence is the fact that in some other species a difference in the development of the ocelli (*N. spinicrus*), the length of antennal segments (*N. roseipennis*), the size of eyes, claspers, and other structures (*N. ferus*), as well as other differences accompany the varying degrees of wing development.

Nabis capsiformis Germar.

1837. *Nabis capsiformis* Germar, Silberm Revue Ent., V, p. 132.
1837. *Nabis angusta* Spinola, Essai sur les Héimp., p. 107.
1848. *Nabis longipennis* Costa, Atti. Inst. Natl. Napol. for 1848, p. 750.

1855. *Nabis caffra* Stål, Öf. Vet. Akad. Förh., XII, p. 39.
1870. *Nabis elongatus* Meyer-Dür, Mitth. Schweiz. Ent. Ges., III, p. 178.
1872. *Nabis capsiformis* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 88, Pl. VIII, fig. 9.
1872. *Nabis kinbergi* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 90.
1878. *Nabis saundersi* White, Ent. Mo. Mag., XV, p. 159.
1896. *Nabis brullei* Lethierry and Severin, Cat. Gen. Hemip., III, p. 208.
1908. *Reduviolus capsiformis* Reuter, Mém. Soc. Ent. Belg., XV, p. 114.
1921. *Nabis capsiformis* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 9.

Elongate, narrow, smooth, somewhat shiny; thinly pubescent and also pilose; pale whitish- to yellowish-testaceous, a median line and two postocular spots on head, median line on pronotum, with pronotal cicatrices, disc of scutellum, lateral stripes on body, meso- and mestasternum in greater part, and median line of venter nigrofuscous. Head longer than broad, the postocular part rather long and parallel sided. Eyes rather prominent, the length of one faintly more than width of vertex. Ocelli conspicuous, placed closer to each other than to the eyes. Antennae moderately long, segment I rather slender, straight, scarcely thickened distally, its length distinctly greater than width of head through eyes (35 : 25) ; II with the usual dark annulus at apex; proportion of segments, 35 : 58 : 55 : 35. Rostrum with segments II and III subequal in length, each distinctly shorter than antennal I.

Pronotum as broad as long or distinctly broader than long; the anterior margin of collar and three obsolete stripes on posterior lobe sometimes brownish fuscous. Scutellum with lateral yellowish. Hemelytra sub-hyaline, somewhat shiny, clothed with a few scattered, short, fine hairs; membrane extending beyond apex of abdomen, with three elongate discal cells. Legs moderately long, concolorous with body, usually immaculate; the anterior femora from 5 to 7 times as long as thick. Male smaller and more slender than female, the clasper with a short, narrow semicircular blade (Plate III, fig. 4). Length, 6.9–9.9 mm., width, 1.32–1.5 mm. (at abdomen, 1.5–1.8 mm.).

Nabis capsiformis is a cosmopolitan species occurring in this country from North Carolina to Texas and southward into South America. The true brachypterous form is not known to occur although the hemelytra vary in development. A male before me, from Pascagoula, Mississippi, has the membrane reaching scarcely beyond the tip of the abdomen while in others at hand it reaches more than half its length beyond the abdomen. The pronotum in this shorter winged form has the anterior lobe almost as highly arched as the posterior. The anterior and intermediate femora often show obsolete indications of the spotting and striping common in other species of the genus. The abdomen is brownish above, with the margins paler. The outer cells of the membrane are often unclosed. The antennae are somewhat variable in length and the claspers show a slight variation in shape. Specimens have been examined from North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, Mississippi, Texas, Mexico, Cuba, Santo Domingo, Trinidad, and South America. The species is said to frequent tall grasses in swampy meadows.

Nabis alternatus Parshley.

1922. *Nabis alternatus* Parshley, S. D. St. Coll., Tech. Bul. 2, p. 12, fig. 1.

Narrow, somewhat elongate, thinly pilose; grayish testaceous, marked with brownish fuscous to black. Head with median line above and two lateral stripes blackish. Pronotum with cicatrices, and median and two lateral lines on anterior lobe blackish; posterior lobe with humeri and five longitudinal stripes on disc brown (the median stripe broader and darker than others). Scutellum dull black, with a yellowish callosity on each side. Hemelytra somewhat shiny, grayish testaceous, rather thickly dotted with fuscous brown. Abdomen above black, the connexivum pale with a conspicuous black spot occupying the basal half of each segment. Thorax beneath largely black. Venter with narrow median and broad lateral stripes brown to black. Antennae testaceous to fuscous, the apex of segment II and all of II and IV darker. Femora distinctly spotted with fuscous to black; the intermediate and posterior tibiae faintly dotted.

Head distinctly longer than broad; the postocular part rather long, parallel-sided. Eyes moderately prominent, the length of one equal to width of vertex. Ocelli conspicuous, placed closer to each other than to the eyes. Antennae moderately long, segment I slightly thickened distally, its length subequal to width of head through eyes (27 : 28); proportion of segments, 27 : 50 : 44 : 25. Scutellum depressed on disc. Anterior femora about $4\frac{1}{2}$ to 5 times as long as thick. Male clasper rather narrow, the diameter of its blade distinctly less than width of an eye viewed from above (Plate III, fig. 11).

Brachypterous form: Pronotum slightly broader than long (male, 46 : 40; female, 53 : 45), the anterior lobe scarcely (female) or equally as highly arched as posterior lobe. Hemelytra narrowed from middle outward; membrane well developed, narrow, extending slightly beyond apex of abdomen, with distinct closed cells. Wings extending to about middle of abdomen. Length, 6.9–7.3 mm.; width, 1.38–1.56 mm. (at abdomen, 1.68–2.1 mm.).

Macropterous form: Pronotum broader than long (male, 50 : 45; female, 56 : 50), the posterior lobe much higher than anterior. Hemelytra well developed, scarcely or completely covering the abdomen; the membrane broad, extending well beyond tip of abdomen. Length, 7.5–8.1 mm.; width, 1.56–1.7 mm. (at abdomen, 1.7–1.9 mm.).

This distinct little species is quite variable in color markings. The short winged form seems to be more common in the higher altitudes and often in this form, and even in some macropterous examples, the spots of the hemelytra and femora are so numerous that they run together, giving a mottled black appearance. In these the abdomen is shiny black above and the connexivum strongly alternated with black. In other examples the hemelytra are very sparsely dotted, the abdomen brownish above, and the connexivum pale throughout. This pale form may be known as variety *uniformis,* n. var. *N. alternatus* was described originally from South Dakota and British Columbia. Specimens from the type localities are before me and in addition numerous examples from the following localities: Washington, Oregon, California, Nevada, Utah, Idaho, Montana, Wyoming, North Dakota, Iowa, Nebraska, Kansas, Colorado, New Mexico, Texas, and Mexico. The species has often been confused in collections with *Nabis ferus* Linn., and is the form that has usually been recorded from America as *N. ferus* var. *punctatus* Costa. There seems, however, to be no good reason for suspecting it to be the true *punctatus* and it should undoubtedly be accorded specific rank.

Nabis alternatus var. **uniformis** n. var.

Form and size similar to typical *alternatus;* differing however in its paler color, less distinctly spotted hemelytra, pale to brownish abdomen, and uniformly pale connexivum.

Holotype, macropterous male, Fresno, California, June 20, 1926, C. J. Drake, collector, and *allotype,* macropterous female, Corvallis, Oregon, June 26, 1926, C. J. Drake, collector, in author's collection. Specimens are before me from California, Oregon, British Columbia, South Dakota, Colorado, New Mexico, and Texas.

Nabis ferus (Linnaeus).

1758. *Cimex ferus* Linnaeus, Syst. Nat., edn. 10, I, p. 449.
1761. *Cimex ferus* Linnaeus, Fauna Suec., edn. 2, pp. 256, 962.
1775. *Cimex ferus* Fabricius, Syst. Ent., p. 726.
1794. *Miris ferus* Fabricius, Ent. Syst., IV, p. 185.
1794. *Miris vagans* Fabricius, Ent. Syst., IV, p. 185.
1861. *Nabis ferus* Fieber, Europ. Hemip., p. 161.
1872. *Nabis ferus* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 72.
1914. *Coriscus ferus* Garman and Jewett, Ky. Agr. Exp. Sta., Bul. 187, pp. 585–587, figs. 12, 13, 14.
1918. *Reduviolus ferus* Osborn, Jl. Agr. Res., XX, pp. 194–197, figs. a–f.
1921. *Nabis ferus* Hickman, Bul. Brookl. Ent. Soc., XVI, p. 59, fig. 10.

Similar to *N. alternatus* var. *uniformis* but larger. More grayish testaceous, usually less distinctly spotted with fuscous and with much larger clasper.

Head longer than broad. Antennae with segment I subequal to width of head through eyes (26 : 28); the segments in proportion, 26 : 48 : 47 : 25. Rostrum with segments II and III subequal, each slightly longer than antennal I (30 : 26). Pronotum broader than long. Anterior femora about $3\frac{1}{2}$ times as long as deep. Male clasper with moderately broad blade (Plate III, fig. 12).

Brachypterous form: Pronotum broader than long (55 : 50). Hemelytra narrowed distally, reaching scarcely to or well beyond apex of abdomen. Length, 7.2–9 mm.; width, 1.5–1.8 mm. (at abdomen, 1.9–2.1 mm.).

Nabis ferus Linnaeus, a Palaearctic species has become common throughout southern Canada and the northern half of the United States from coast to coast. It is quite variable in size, in the amount of fuscous markings, in the length of the antennal segments, and to some extent in the shape of the clasper of the male. Specimens taken in early spring (over-wintered examples) and specimens from higher localities are almost invariably darker and more distinctly and thickly marked with fuscous than others. More than a thousand examples have been examined from the following localities: Quebec, Maine, New York, Connecticut, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Illinois, Tennessee, Mississippi, Missouri, Iowa, Minnesota, North Dakota, Nebraska, Kansas, Colorado, Montana, Alberta, British Columbia, Washington, Oregon, California, and Arizona.

Biology: Several workers have published observations on the life and habits of this common nabid. The author has followed the complete life cycle as it occurs in the vicinity of Ames, Iowa. The insect hibernates in the adult stage. Eggs, as in all other nabids, are deposited in the stems of grasses. They hatch in about eight days. The nymphs undergo five moults, the first four instars requiring an average of three days each while the last instar requires about six days. The species prefers more sunny and drier situations than do most of the other common species of the genus. The younger nymphs wander about on the ground where their color and shape blends remarkably well with the dead and dying grass blades and seeds. The older nymphs venture to climb the higher grass stems but upon the least disturbance they loosen their hold and fall to the bases of the plants. The adults often invade the fields and gardens where they prey upon aphids, leaf-hoppers, and caterpillars.

Nabis ferus var. **pallidipennis** n. var.

Usually smaller and slender than typical *ferus,* the color more of a pale yellowish testaceous; hemelytra somewhat translucent, immaculate except for three prominent brown spots on outer vein of corium. Abdomen above pale yellowish to brownish. Eyes usually less prominently rounded than in typical *ferus.* Antennae longer than in typical form, segment I longer than width of head through eyes (31 : 27); proportion of segments, 31 : 55 : 56 : 35. Pronotum equally as broad as long (42 : 42), gradually widened backwards, the sides almost straight. Hemelytra narrowed posteriorly, extending to or beyond tip of abdomen, cells of membrane often unclosed. Male with clasper as in typical form. Macropterous form with slightly larger eyes, otherwise, except for wing development, as in brachypterous form. Length, 6.7–8.5 mm.; width, 1.3–1.7 mm. (at abdomen, 1.5–2.1 mm.).

Holotype, brachypterous male, *allotype,* brachypterous female, and *morphotype,* macropterous male, all taken at Cedar Falls, Iowa, July 17, 1926, H. M. Harris, collector. *Paratypes,* many males and females taken with the types. This form may, when only a few examples are at hand, appear sufficiently distinct to be accorded specific rank. However, with a long series for study it is evident that the differential characters are quite variable. It seems to be no more than a form of our very variable *N. ferus* that is characteristic of drier and warmer situations. The entire type series was taken on a typical high Iowa prairie. In addition to them specimens from New York, Pennsylvania, Ohio, and Minnesota are at hand. Some of these closely approached *N. capsiformis* in appearance.

Nabis inscriptus (Kirby).

1837. *Reduviolus inscriptus* Kirby, Richardson's Fauna Bor. Amer., IV, p. 280, pl. 6, fig. 7.

Similar to *N. ferus* Linn., from which it differs in its shorter antennae, larger eyes, more incrassate anterior femora, and differently formed clasper of the male.

Oblong-ovate, yellowish to grayish testaceous, marked with fuscous to black as in related species. Head longer than broad. Eyes rather prominent, the length of one slightly greater than width of vertex. Antennae only moderately long, length of segment I distinctly less than width of head through eyes; the proportion of segments, 24 : 37 : 37 : 25. Rostrum with segment II and III subequal, each slightly longer than antennal I. Pronotum slightly broader than long. Hemelytra clothed above with short, semierect, rather rigid, yellowish brown hairs; the costal margin broadly rounded; membrane narrow, extending about to apex of abdomen, with the usual closed cells. Male clasper with the blade not so broadly rounded as in *ferus.* Anterior femora about 3 times as long as thick. Length, 6.2 mm.; width, 1.38–1.5 mm. (at abdomen, 2–2.3 mm.) (Plate III, fig. 10).

Nabis inscriptus, described from a brachypterous female said to have been taken in latitude 65° Boreal America, has long puzzled students of Hemiptera. Reuter in 1908 (Mém. Soc. Ent. Belg., XV, p. 120) and again in 1913 (Öfver. Finska Vet. Soc. Förh., LV, No. 14, p. 82) published descriptions of what he took to be this species, basing his studies on specimens from Colorado. He identified the *N. boreelus* Reuter, which is said to have a wide distribution in the northern Palaearctic regions, as only a color variety of *inscriptus.* The present author has had the good fortune of being able to study a male specimen from Colorado determined by Dr. Reuter. It is a brachypterous specimen bearing the labels, Colorado, 2158, C. F. Baker collection, and undoubtedly is the one upon which Reuter bases his determination of *N. inscriptus* as his specimen bore the same label. (He had three specimens from Colorado, only one of which was a male.) This specimen however is no more than a short-winged *N. ferus* Linn., perhaps a little dark in color, yet in no way different from others, both brachypterous and macropterous males and females, before me. The darker color would be expected of a form inhabiting the higher altitudes. There is at hand however, a long series of brachypterous males and females of a form that I have elected to call *N. inscriptus* (Kirby). These were taken at Pingree Park and Estes Park, Colorado, 1923–1925, by C. J. Drake. They agree in more exactly representing the form and color as depicted in Kirby's figure than does the specimen determined by Reuter and also the clasper of the male is constantly different from that of *N. ferus.* Furthermore, and what seems most convincing, is the fact that the range is such that it may well have been taken in latitude 65° north for there are specimens at hand from Moscow, Idaho, and in Alberta, Canada, from Calgary, Edmonston, and Slave Lake, these latter collected by O. Bryant. There is also a specimen at hand, belonging to the Field Museum of Chicago, from Skilah Lake, Alaska, collected September, 1913, by J. Friesser. This specimen, a male, is peculiar in that it is almost entirely dark testaceous to black throughout. Three specimens from Montreal, Canada, belonging to the British Museum (kindly loaned to me by W. E. China and determined by E. A. Butler as *N. inscriptus* Kirby), are all brachypterous examples of *N. roseipennis* Reuter (Plate I). Also there is in the Kirkaldy collection a specimen of *N. alternatus* Parshley from California that bears the label *Nabis inscriptus.* Many specimens of *rufusculus, roseipennis* and *ferus* from the eastern states have been sent to me labelled as *N. inscriptus.*

Genus METATROPIPHORUS Reuter

1872. *Metatropiphorus* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 93.

1873. *Metatropiphorus* Stål, Enum. Hemip., III, p. 110.

Elongate, anteriorly narrowed, pubescent. Head constricted at basal margin of eyes, the postocular part somewhat globose. Eyes moderately large, coarsely granular. Ocelli distinct, rather close together, placed behind the base of the eyes. Antennae moderately long; segment I much longer than head, suddenly and evenly thickened along basal third. Rostrum slender, segment II longer than III. Pronotum broader than long, strongly constricted slightly behind the middle; collar narrow, less distinctly marked off than in *Nabis;* posterior lobe strongly raised, the disc punctate, the basal margin straight. Scutellum opaque, unicolorous, the disc slightly depressed, without foveae; the apex truncate, slightly raised. Hemelytra extending well beyond tip of abdomen, the membrane without closed cells. Legs moderately long; anterior femora of almost equal thickness throughout, armed beneath with numerous short piceous spine-like teeth; anterior tibiae short, thick, armed within with piceous spines, without a spongy fossa at apex; intermediate and posterior tibiae unarmed. Anterior acetabula rather strongly produced, extending laterally beyond sides of pronotum and visible from above. Metapleuron opaque, the ostiolar canal shiny, evenly raised, posteriorly directed. (Type, *M. belfragii* Reuter.)

This genus is easily recognized by the elongate, distally swollen first antennal segment, the coarsely granulate eyes, the laterally projecting anterior coxal cavities, the unarmed intermediate tibiae, and the absence of spongy pads at the ends of the anterior and intermediate tibiae. The antenniferous tubercules are rather strongly, obliquely produced forward, so that the head appears widened in front of the eyes. The genus is represented in the United States by a single described species. A second species, occurring in Porto Rico, is here added and a third, occurring in China, is said to belong to this genus.

Key to Species of Metatropiphorus

Second antennal segment almost two-fifths longer than first; anterior femora about 7 times as long as thick...*belfragii* Reut., p. 72.

Second antennal segment scarcely one-fifth longer than first; anterior femora scarcely more than 5 times as long as thick.
drakei n. sp., p. 73.

Metatropiphorus belfragii Reuter

1872. *Metatropiphorus belfragii* Reuter, Öf. Vet. Akad. Förh., XXIX, No. 6, p. 94.

1876. *Metatropiphorus belfragii* Uhler, Bul. U. S. Geol. Geog. Surv., I, p. 325.

1914. *Metatropiphorus belfragii* Barber, Bul. Am. Mus. Nat. Hist., XXXIII, p. 502.

1916. *Metatropiphorus belfragii* Barber, Jour. N. Y. Ent. Soc., XXIV, No. 4, p. 308.

1920. *Metatropiphorus belfragii* Torre-Bueno, Bul. Brookl. Ent. Soc., XV, p. 70.

Slender, testaceous, with grayish pubescence; the head, antennae, markings on anterior lobe of pronotum, scutellum, body beneath, tarsi, apices of tibiae, and a broad apical annulus at apex of each femur piceo-testaceous. Head distinctly longer than broad. Eyes moderately prominent, the length of one almost twice as great as width of vertex. Antennae moderately long, segment I almost three times as long as the width of head through eyes (56:20); proportion of segments, 56:76:53:27. Rostrum with segment I equally as broad as long; segment II much longer than III (25:16).

Pronotum slightly broader than long (46:42); the posterior lobe arched, rugosely punctate, the humeri prominent. Scutellum slightly depressed on the disc. Hemelytra pubescent, also with a few fine hairs, rather obsoletely rugulosely punctate, the veins prominent; often with a distinctly paler patch on clavus at apex of scutellum, another at middle of corium, and a third near apex of corium opposite the middle of membrane. Membrane long, the veins fuscous, prominent. Legs in greater part testaceous, the anterior and intermediate femora with piceous spots and bars; anterior femora about 7 times as long as thick (78:11). Venter in greater part piceous black. Male with small, distinctive clasper (Plate IV, fig. 6). Length, 6.9–7.2 mm.; width, 1.35 mm. (at abdomen, 1.44 mm.).

The species was described from Texas and has since been recorded from West Indies, Florida, North Carolina, Virginia, District of Columbia, Maryland, New Jersey, New York, and Illinois. Specimens from Mississippi, Connecticut, District of Columbia, Florida, Illinois, and Iowa are before me. The Iowa specimens, eight of them, were taken in the summer of 1927 by Mr. H. G. Johnston and the writer. They were taken singly, never more than one from a locality, and always by beating tall shrubs and trees. Nothing is known of the life cycle of the species.

Metatropiphorus drakei n. sp.

Similar to *M. belfragii* but smaller, with shorter and paler legs and antennae, and with differently shaped clasper of male.

Head pale testaceous in front of eyes. Antennae with most of segment I and the base of segment II pale; segment

I slightly more than two times as long as width of head through eyes (40 : 18) ; the proportion of segments, 40 : 46 : 36 (IV absent). Rostrum with segment II about one-half longer than III (18 : 13). Pronotum slightly broader than long (37 : 33), rather thickly clothed with grayish pubescence, the posterior lobe with a shiny median line. Scutellum considerably smaller than in *belfragii*. Hemelytra extending well beyond apex of abdomen. Legs flavo-testaceous, the markings as in *belfragii* but more brownish; anterior femora equally as thick as in *belfragii* but much shorter, scarcely more than five times as long as deep (58 : 11). Male clasper smaller than in *belfragii*, triangular (Plate IV, fig. 5). Length, 5.7 mm.; width, 1.1 mm.

Described from a male, *holotype*, Utuado, Porto Rico, April 8, 1900, in author's collection. It is my pleasure to name this species after Dr. Carl J. Drake who is responsible for my interest in the Nabidae and who presented me with the first specimen of the Genus *Metatropiphorus* that it was ever my privilege to examine.

Genus CARTHASIS Champion

1900. *Carthasis* Champion, Biol. Centr. Amer., Heter., II, p. 305.

1901. *Orthometrops* Uhler, Proc. Ent. Soc. Wash., IV, p. 508.

Small, elongate, somewhat shiny, sparsely pilose. Head exserted, somewhat widened anteriorly to the prominent antenniferous tubercles, with a distinct transverse depression between the eyes. Ocelli absent. Eyes rather prominent, coarsely granulate. Antennae moderately long, segments III and IV much thinner than I and II. Rostrum slender, four-segmented, segment I as broad as long.

Pronotum with anterior lobe sub-cylindrical, the collar wide but not sharply marked off; posterior lobe emarginate at base. Scutellum equilateral, the disc flat, without lateral callosities. Hemelytra strongly constricted before the middle. Anterior acetabula placed far forward, obliquely projecting anteriorly and readily visible from above; closed behind. Anterior femora slightly incrassate, minutely denticulate beneath and also with numerous rigid setiform spines; anterior tibiae shorter than femora, spinose within, provided with a spongy pad at the apex. Intermediate and posterior tibiae unarmed, provided with apical pads as in anterior ones. Tarsi uniarticulate. (Type, *C. rufonotatus* Champion.)

The genus *Carthasis* is easily recognized by the small size, absence of ocelli, elongate anterior coxae, and the peculiar structure of the fore acetabula. It has its nearest ally in our American fauna in the genus *Neogorpis* Barber. Blatchley in his Heteroptera of Eastern North America (1926, p. 538) has placed the genus with the *Reduviidae* and erected for it the subfamily *Carthasinae.* It is my opinion however that that author has not made a sufficiently close study of the related genera (*Gorpis* Stål, *Veronia* Buch.-White, and *Neogorpis* Barber) to be qualified to transpose the group from one family to another. The genus as now known contains seven species, two of which are described below as new.

Key to Species of Carthasis

1. Gula without setiform spines, but with several long fine hairs; hemelytra with numerous erect hairs 2
   Gula with four rigid, setiform spines; hemelytra without erect hairs 3
2. Pronotum distinctly longer than broad, with an obsolete darker stripe on each side of the paler median stripe; posterior lobe raised scarcely higher than anterior .... **uhleri** n. sp., p. 76
   Pronotum slightly broader than long, median portion of anterior lobe and a broad transverse fascia on posterior lobe brownish to fuscous; posterior lobe strongly raised above anterior. **championi** n. sp., p. 76
3. Length of first antennal segment distinctly less than twice the width of head through eyes 4
   Length of first antennal segment subequal to twice the width of head through eyes 6
4. Segment I of antennae one-third longer than the head; pronotum with a median darker stripe or line; form slender. *gracilis* Harris, p. 77
   Segment I of antennae and head subequal in length; pronotum with a median paler stripe; form less elongate 5
5. Antennae with segment II distinctly longer than I; pronotum with anterior lobe not strongly arched, posterior lobe scarcely higher than anterior .... *distinctus* Harris, p. 78
   Antennae with segment II slightly shorter than I; pronotum with anterior lobe arched, the posterior lobe suddenly and strongly raised .... *minor* Reuter, p. 79
6. Antennal segment II distinctly longer than I; rostral segment II shorter than III and IV conjoined. *decoratus* (Uhler), p. 80

Antennal segments I and II subequal; rostral segment II subequal to III and IV conjoined.............*rufonotatus* Champ., p. 81

Carthasis uhleri n. sp.

Elongate, pilose; flavo-testaceous, the head above, antennae, a broad stripe on each side of disc of pronotum, scutellum, inner part of clavus, a transverse fascia on hemelytra at apex of clavus, and membrane (except for a spot opposite apex of corium) darker, brownish testaceous. Head longer than broad, the under surface with several long, fine hairs. Eyes prominent, coarsely granulated, the length of one slightly greater than width of vertex. Antennae long, pilose, segment I about twice as long as the width of head through eyes (35:18), thicker than others; proportion of segments, 35:32:29:48. Rostrum with segment II as long as III and IV conjoined.

Pronotum distinctly longer than broad; anterior lobe (median measurement) twice as long as posterior and almost as high. Hemelytra with a prominent crimson patch in the outer apical angle, the veins and costal margin with numerous upright hairs; membrane extending beyond apex of abdomen, its veins indistinct. Anterior femora about eight times as long as thick (47:6). Venter constricted at base, the apex with two extremely long fine hairs arising from the last connexival segment and projecting laterally on each side. Male clasper as in figure (Plate IV, fig. 11). Length, 4 mm.; width, .75 mm. (at abdomen, .88 mm.).

Holotype, male, Cacao, Trece Aguas, Alta V. Paz, Guatemala, March 30, Schwarz and Barber, collectors. (Type in U. S. National Museum). *Paratype,* male, Livingston, Guatemala, May 7, H. S. Barber, collector.

This distinct little species differs from all previously described members of the genus in that the spine-like setae of the gula are absent and the body is more hairy. These hairs are particularly conspicuous on the gula, the first and second rostral segments, the anterior coxae and femora, the venter, and the hemelytra, scutellum, and pronotum. The venter is also finely pubescent. The holotype has the darker markings slightly more pronounced than does the paratype. The markings of the pronotum leave a median stripe, obliquely widened on posterior lobe, pale.

Carthasis championi n. sp.

Elongate, pilose, also finely pubescent; flavo-testaceous, the head, anterior lobe of pronotum, and a transverse fascia on disc of posterior lobe brownish to fuscous; hemelytra marked as in *C. uhleri,* the membrane also with an apical pale spot; scutellum with a reddish tinge; mesosternum fuscous brown. Head slightly longer than broad, clothed beneath with several long fine hairs as in *C. uhleri.* Eyes prominent, the length of each slightly greater than width of vertex. Antennae flavo-testaceous, the terminal segment darker, segment I distinctly less than twice as long as width of head through eyes (33:20); proportion of segments, 33:30:27:47. Rostrum as in *uhleri.*

Pronotum slightly broader than long, the anterior lobe (median measurement) scarcely twice as long as posterior; the collar more sharply marked off than in *uhleri;* the posterior lobe much higher than anterior. Hemelytra clothed as in *uhleri,* more strongly widened beyond the middle than in that species. Anterior femora eight times as long as thick (48:6). Venter strongly widened beyond the middle. Length, 4.4 mm.; width, .88 mm. (at abdomen, 1.04 mm.).

Holotype, female, David, Chiriquí, Panamá, Champion, in collection of British Museum of Natural History. This specimen is a cotype of Dr. Champion's *C. rufonotatus,* that author having included two species in his original description. *C. championi* n. sp. is at once separated from the true *rufonotatus* by the absence of the spine-like setae on the gula. In this respect it agrees with *C. uhleri* n. sp. from which it may be separated by the different color markings which are somewhat darker, and especially by the differently formed pronotum. In *uhleri* the disc of the pronotum is almost level; in *championi* the anterior lobe is arched, and the posterior lobe is raised much above the anterior. Also in the former is the pronotum clothed with scattered upright hairs, while in the latter it is thickly clothed with recumbent pubescence. The anterior acetabula open not so obliquely forward as in *uhleri.*

Carthasis gracilis Harris.

1925. *Carthasis gracilis* Harris, Bul. Brookl. Ent. Soc., XX, p. 172.

Elongate; flavo-testaceous, the head, a median stripe on pronotum (widened on posterior lobe), inner margin of clavus, and a prominent patch at inner apical angle of corium and another at apex, crimson. Scutellum reddish. Head longer than broad, the anteocular part thickly pubescent; provided beneath with four slender seta-like spines.

Eyes prominent, slightly smaller than in other known species of the genus. Antennae pale, somewhat darkened distally, segment I distinctly longer than width of head through eyes (23 : 14) ; proportion of segments, 23 : 26 : 25 : 37. Rostrum with segment II shorter than III and IV conjoined (11 : 13).

Pronotum smooth, shiny, slightly longer (median measurement) than broad, the anterior lobe one-half longer than posterior and about equally as high. Scutellum with only a few fine hairs. Hemelytra shiny, only the costal margin along its basal half with hairs. Membrane fuscous, a large spot on either side at apex of corium lighter. Anterior femora more than five times as long as thick (34 : 4). Venter pale stramineous, pubescent, and also with a few scattered longer hairs. Clasper as in figure (Plate IV, fig. 14). Length, 3.3–3.8 mm.; width, .55–.6 mm. (at abdomen, .58–.68 mm.).

This form, the slenderest of our known species of the genus, was originally described from two male specimens from Cuba. In addition to these there are two females, from Bolondrón, P. de Guanahacabibes, Cuba (*allotype*), and Rio Piedras, Porto Rico, respectively, before me. The markings are slightly variable, the head and scutellum sometimes being much darker than at others. In the Porto Rico specimen the pronotal stripe is almost obsolete and the spots of the hemelytra are not connected, while in two of the Cuban specimens the pronotal stripe is quite dark and there is a crimson line along the outer margin of corium extending from apex of clavus to apex of corium, thus serving to connect the crimson patches.

Carthasis distinctus Harris.

1925. *Carthasis distinctus* Harris, Bul. Brookl. Ent. Soc., XX, p. 173.

Form broader than in *C. gracilis;* the color markings about as there except for pronotum, this with a broad reddish stripe on either side of a pale median one, the stripes strongly divaricating posteriorly onto humeri. Head longer than broad, armed beneath as in *gracilis,* the spines shorter. Eyes slightly larger than in *gracilis,* the length of one greater than width of vertex. Antennae only moderately long, segment I about equally as long as head, only about one-third longer than width of head through eyes (19 : 15) ; the proportion of segments, 19 : 23 : 19 : 30. Rostrum with segment II distinctly shorter than III and IV conjoined (9 : 14).

Pronotum equally as broad as long, the anterior lobe about one-half longer than posterior and almost equally as high. Scutellum and hemelytra colored as in *gracilis*, but darker. Anterior femora only five times as long as thick (35 : 7), each with an obsolete darker spot above before the apex. Anterior tibiae slightly curved inwards. Abdomen above with a subapical crimson patch. Clasper hook-like (Plate IV, fig. 9). Length, 3.5–4 mm.; width, .66–.82 mm. (at abdomen, .70–.88 mm.).

This distinct species was originally described from Cuba and is known only from the type localities. It is readily recognized by its broader form, shorter antennae, more incrassate anterior femora, and especially by the hook-like clasper of the male.

Carthasis minor Reuter.

1908. *Carthasis minor* Reuter, Mém. Soc. Ent. Belg., XV, p. 97.

1925. *Carthasis minor* Harris, Bul. Brookl. Ent. Soc., XX, p. 174.

Moderately elongate, pubescent; testaceous to flavo-testaceous, the head above, pronotum except for dscal patch, scutellum, and clavus more or less rufous; a transverse fascia on hemelytra before the middle of the corium light fuscous to testaceous; a spot at middle of corium and a large patch at apex of corium (these connected by an interrupted line along apical margin) crimson. Head paler in front, thickly pubescent, longer than broad; beneath pale, with four short seta-like spines. Eyes red, large, coarsely granular. Antennae flavo-testaceous, the apical segments darkened, segment I subequal to the head in length, slightly longer than width of head through eyes (20 : 17); proportion of segments, 20 : 19 : 18 : 30. Rostrum with segment II one-third shorter than III and IV conjoined.

Pronotum longer than broad, strongly constricted behind the middle; anterior lobe strongly arched, one-half longer than posterior; posterior lobe abruptly and strongly raised above the anterior (Plate IV, fig. 13). Hemelytra strongly constricted before the middle, with a few upright hairs on clavus and corium, the latter also thinly pubescent. Membrane fuscous, a large patch on each side of apex of corium and the outer margin paler. Legs flavo-testaceous, the anterior femora with a reddish band just beyond the middle. Mesosternum darkened. Venter light testaceous, thinly pubescent, also with a few long hairs. Genital segments crimson above, the claspers similar in outline to *C. decoratus* (Plate IV, fig. 8). Length, 3.48 mm.; width, .6 mm.

This species is, as I have previously pointed out, not to be confused with other members of the genus. It is easily recognized by the form of the pronotum, the anterior lobe being arched and the posterior lobe strongly and suddenly raised. The anterior lobe of the pronotum is rufous with its disc and the acetabula seen from above pale; the posterior lobe light testaceous. The anterior femora are much thicker than in *C. decoratus* Uhler, resembling *C. distinctus* in this respect, and each is marked slightly beyond its middle with a reddish band. The species is known only from Jamaica, West Indies.

Carthasis decoratus (Uhler).

1901. *Orthometrops decoratus* Uhler, Proc. Ent. Soc. Wash., IV, p. 509.
1908. *Carthasis contrarius* Reuter, Mém. Soc. Ent. Belg., XV, p. 97.
1916. *Carthasis decoratus* Barber, Jour. N. Y. Ent. Soc., XXIV, p. 308.

Elongate, shiny; pale stramineous to flavo-testaceous, the head in greater part, a broad median stripe on pronotum (widened on posterior lobe), scutellum, and clavus testaceous to rufous (sometimes more or less crimson); a prominent spot at inner apical angle of corium, a larger one at outer apical angle, and sometimes an interrupted line along outer margin (connecting the two spots) crimson. Head slightly longer than broad, thinly pubescent; armed beneath with four seta-like spines. Eyes prominent, the length of one slightly greater (female) or equal to (male) width of vertex. Antennae slender, finely, thickly pubescent, flavo-testaceous, the apical segments darkened; segment I often with a reddish tinge, about twice as long as width of head through eyes (33 : 17); the proportion of segments, 33 : 38 : 30 : 48. Rostrum with segment II shorter than III and IV conjoined.

Pronotum about as broad as long, clothed with a few fine hairs; the anterior lobe finely rugulose, about one-half longer (median measurement) than posterior; posterior lobe smooth, distinctly raised above the anterior. Scutellum with a few long erect hairs. Hemelytra shiny, finely rugulosely punctulate, with a few long hairs on clavus and along costal margin before the constriction; membrane smoky, a large spot opposite apex of clavus (extending around margin to apex) pale. Legs pale, clothed as in other species; the anterior femora about 7½ times as long as thick (45 : 6). Venter finely pubescent, also with a few scattered long hairs. Clasper as in figure (Plate IV, fig. 12). Length, 3.82–4.56 mm.; width, .7–.8 mm. (at abdomen, .74–.97 mm.).

Carthasis decoratus was originally described from Bladensburg, Maryland, and from Pennsylvania and New Jersey. It is now known to range throughout the eastern states. The darker markings of the head and pronotum vary from testaceous to rufous. Specimens have been examined from the following localities: Bogalusa, Louisiana, June 15, H. H. Knight; in Mississippi from Durant, Columbus, Weir, Port Gibson, and Crowder, July to Sept., C. J. Drake and H. M. Harris; Glen Echo, and Bladensburg, Maryland; White Plains, New York, Aug. 4, J. R. de la Torre-Bueno; and Black Mountain, North Carolina, Sept. 9, S. C. Bruner. The specimen from Bladensburg, Maryland, belonging to the H. E. Summer's collection, bears the exact collection data as did Reuter's type of *C. contrarius*. The Mississippi specimens were taken by beating low trees and bushes.

Carthasis rufonotatus Champion.

1900. *Carthasis rufonotatus* Champion, Biol. Centr. Amer., Heter., II, p. 306, Tab. XIX, figs. 4, 4a (in part).
1925. *Carthasis rufonotatus* Harris, Bul. Brookl. Ent. Soc., XX, p. 174.

As is pointed out above (vide *C. championi*, n. sp.) Champion's description of this species is a composite one, that author having had two species before him. Unfortunately no specimens of *rufonotatus* are at hand. However, Mr. W. E. China of the British Museum has kindly compared specimens of *C. decoratus* Uhler with the types of *rufonotatus* and writes in part as follows:

> "Champion has evidently confused two species under his *Carthasis rufonotatus* and his description appears to be a composite one. His figures, whilst being structurally accurate for one species, are not correctly colored. All his specimens are females. Of the five specimens mentioned by him from Panamá, only four remain, the one from Bugaba having been apparently lost. The type specimens (two on one card), from which the drawing but not the coloring of his

figure was made, are from Caldera and agree with a female from Tole in having four bristle-like spines on the gula. Indeed this species is closely related to *C. decoratus* Uhler and agrees quite well with Reuter's description of *C. contrarius*. It differs, however, from your specimen of *C. decoratus* in having the second antennal segment equal to instead of longer than the first; the red pigment on the head, scutellum and inner margin of clavus (present in your specimen) is also more or less obsolete, although the red spots on the inner and outer apical angles of the corium, the coloring of the membrane and the broad median vitta on the anterior pronotal lobe are the same; the pleura are concolorous pale stramineous."

From this then it is evident that *C. rufonotatus* is very close to and possibly synonymous with *C. decoratus* Uhler. However, in all of the specimens of the latter that I have examined, the second antennal segment is distinctly longer than the first.

Genus NEOGORPIS Barber

1924. *Neogorpis* Barber, Jour. N. Y. Ent. Soc., XXXII, p. 136.

"The body is more slender than in *Gorpis*. The head is elongate, cylindrical and porrect, subequally long as the anterior lobe of the pronotum; anteocular part of head much longer than the postocular, the latter more swollen; ocelli absent. Rostrum shorter than in *Gorpis,* reaching only to apex of prosternum, second segment about one-third longer than third. Antennae long and slender, inserted midway between apex of head and eyes, first segment nearly as long as head and anterior lobe of pronotum together and about two-thirds as long as second segment, the last two segments capillaceous, with the first of these much longer than the ultimate. Pronotum dull, not pilose, much longer than wide; collar very wide, not sharply delimited; anterior lobe a little longer and little narrower than the posterior lobe, impunctate; humeral angles unarmed. Scutellum swollen, elongate, impunctate, almost twice as long as wide, apex not laterally contracted, slightly obtuse. Hemelytra very elongate, a little longer than the abdomen, impunctate, very convex, parallel-sided; commissure about four times as long as scutellum; membrane not plainly demarked from the corium, the latter provided with two veins, the inner one forked opposite to apex of commissure; veins of the membrane very faint. Propleurae as seen dorsally much dilated; anterior acetabulae excised before middle of prosternum, closed behind; anterior coxae elongate; legs elongate with the anterior femora somewhat incrassate, densely setose beneath and provided with a few small teeth; anterior tibiae slightly shorter than the femora, very slightly curved and provided inwardly through entire length with small acute oblique spines; apex of posterior femora not incrassate nor nearly reaching to apex of hemelytra.

Genotype: *Neogorpis neotropicalis* Barber.''

Only one species is known.

Neogorpis neotropicalis (Barber).

1923. *Gorpis neotropicalis* Barber, Amer. Mus. Novitates, No. 75, p. 8.

1924. *Neogorpis neotropicalis* Barber, Jour. N. Y. Ent. Soc., XXXII, p. 136.

''Sordid yellow-white; antennae, dorsum of head in part, scutellum posteriorly, streak on clavus posteriorly and also along inner and apical margin of corium, rostrum, apices of all femora, base and apex of all tibiae, dilute red.

''Head smooth, shining, plainly pilose below and with a few scattered long hairs above; space between the eyes subequal to that of diameter of eye itself; ocelli not discernible, sides of tylus longitudinal streak on the vertex and a V-shaped fascia running back from the center of the eyes to base, dilute red. Antennae finely pilose, irrorate with red on the two basal segments, basal segment about as long as head and the anterior lobe of the pronotum taken together, apex slightly incrassate, two-thirds as long as second; third segment one-third shorter than first; fourth segment over one-half, nearly two-thirds as long as third segment. Rostrum finely pilose, with short, thick basal segment, second segment one-third longer than third, fourth less than one-half the length of third. Pronotum dull, non-pilose, obtusely constricted behind middle, with the anterior lobe exclusive of collar a trifle longer than posterior lobe; disk of both lobes impunctate, with a few coarse punctures along the sides posterior to the transverse stricture; anterior lobe with a faint median sulcus; humeral angles unarmed, provided with an elongated rounded prominence; posterior margin evenly arcuated, not straight before the base of scutellum. Scutellum impunctate, slender, transversely depressed before the middle; disk behind this somewhat swollen, dilute red; apex depressed, very acute. Hemelytra dull, obsoletely wrinkled; clavus posteriorly dilute reddish; corium with costal margin from close to base narrowly expanded; inwardly streaked with dilute red close to and along apical half of clavus extending to beyond base of membrane, another similar streak along the inner margin of corium next to the membrane which does not quite reach the apex of corium; apex of corium reaching back as far as apex of abdomen; membrane pale, reaching well beyond. Wings reaching apex of abdomen. Legs long and slender with long pile; fore femora slightly incrassate, almost straight, provided above with a few scattered long hairs and below densely clothed with numerous spinules interspersed with slender bristles and hairs; fore tibiae curved at base, gently curved apically from middle, inwardly serrate, serrations tipped with downwardly curved setae; towards apex rather abruptly expanded and armed inwardly with a stout, curved spine or process extending beyond apex of tibia. Propleuron coarsely punctate; mesopleuron smooth, broadly whitish pruinose except along outer margin. Venter smooth, shining; genital segment of male finely pilose, provided on either side with an upwardly directed, curved and somewhat twisted acute genital hook, curving toward median line. Length, 12 mm.''

Known only from the types from Porto Rico in the collection of the American Museum of Natural History.

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PLATE II

Fig. 1. *Nabis subcoleoptratus* (Kirby), male clasper.
Fig. 2. *N. heidemanni* (Reut.), male clasper.
Fig. 3. *N. sordidus* Reut., male clasper.
Fig. 4. *N. dentipes* (new name for *crassipes* Reut.), male clasper.
Fig. 5. *N. deceptivus* n. sp., male clasper.
Fig. 6. *N. nigriventris* Stål, male clasper.
Fig. 7. *N. spinicrus* Reut., male clasper.
Fig. 8. *N. annulatus* Reut., male clasper.
Fig. 9. *N. constrictus* Champ., male clasper.
Fig. 10. *N. gerhardi* Harris, male clasper.
Fig. 11. *N. panamensis* Harris, male clasper.
Fig. 12. *N. lovetti* Harris, male clasper.

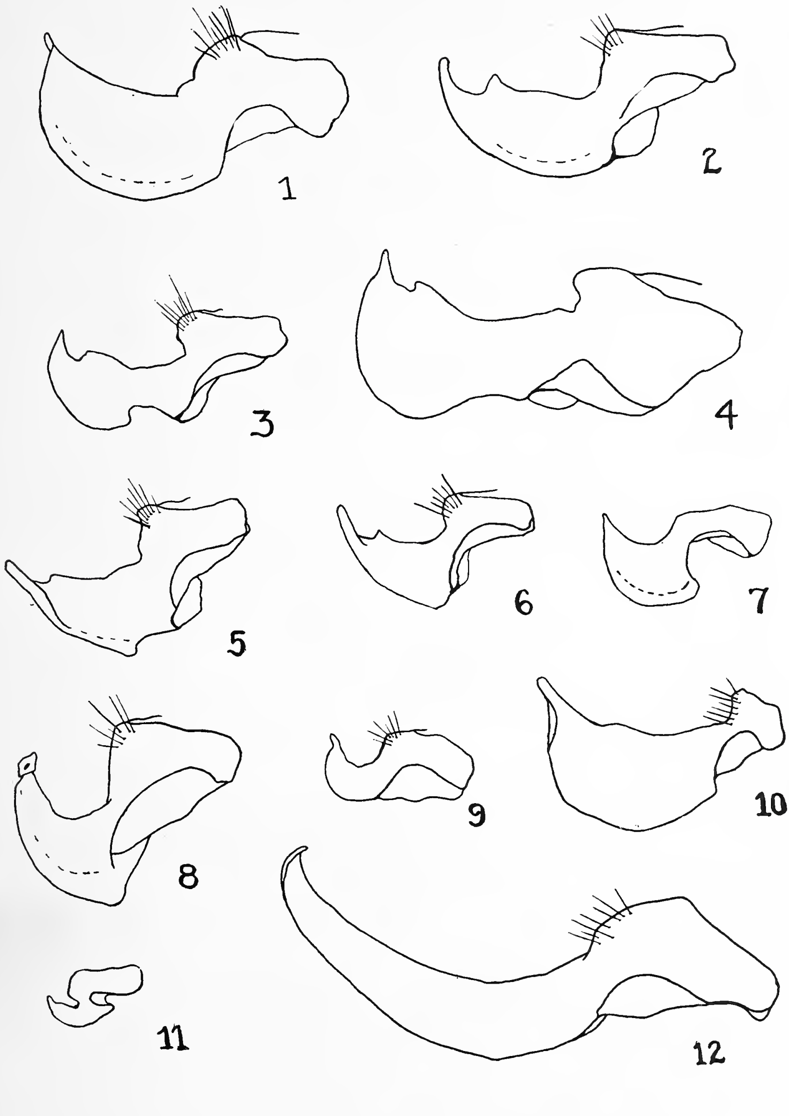
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PLATE III

FIG. 1. *Nabis propinquus* Reut., male clasper.
FIG. 2. *N. flavomarginatus* Scholtz, male clasper.
FIG. 3. *N. nigrovittatus* Sahlb., male clasper.
FIG. 4. *N. capsiformis* Germar, male clasper.
FIG. 5. *N. limbatus* Dahlb., male clasper.
FIG. 6. *N. roseipennis* Reuter, male clasper.
FIG. 7. *N. vanduzeei* (Kirk.), male clasper.
FIG. 8. *N. rufusculus* Reut., male clasper.
FIG. 9. *N. kalmii* Reut., male clasper.
FIG. 10. *N. inscriptus* (Kirby), male clasper.
FIG. 11. *N. alternatus* Parshley, male clasper.
FIG. 12. *N. ferus* (Linn.), male clasper.

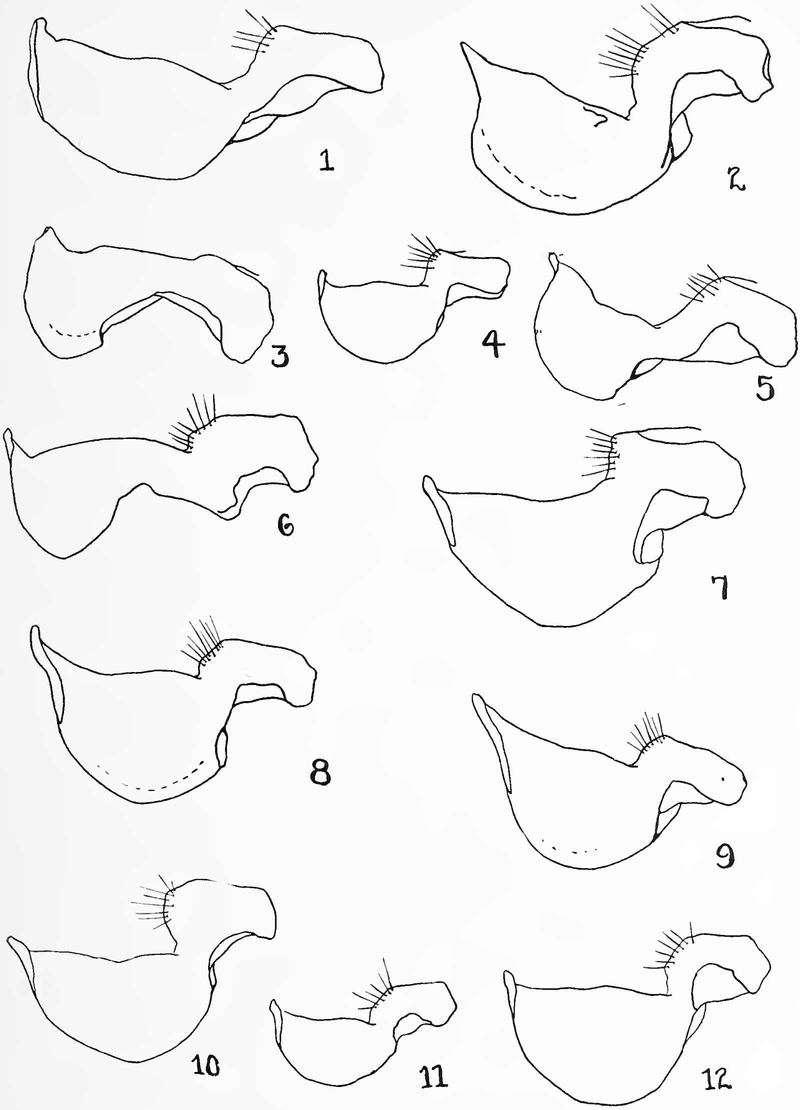
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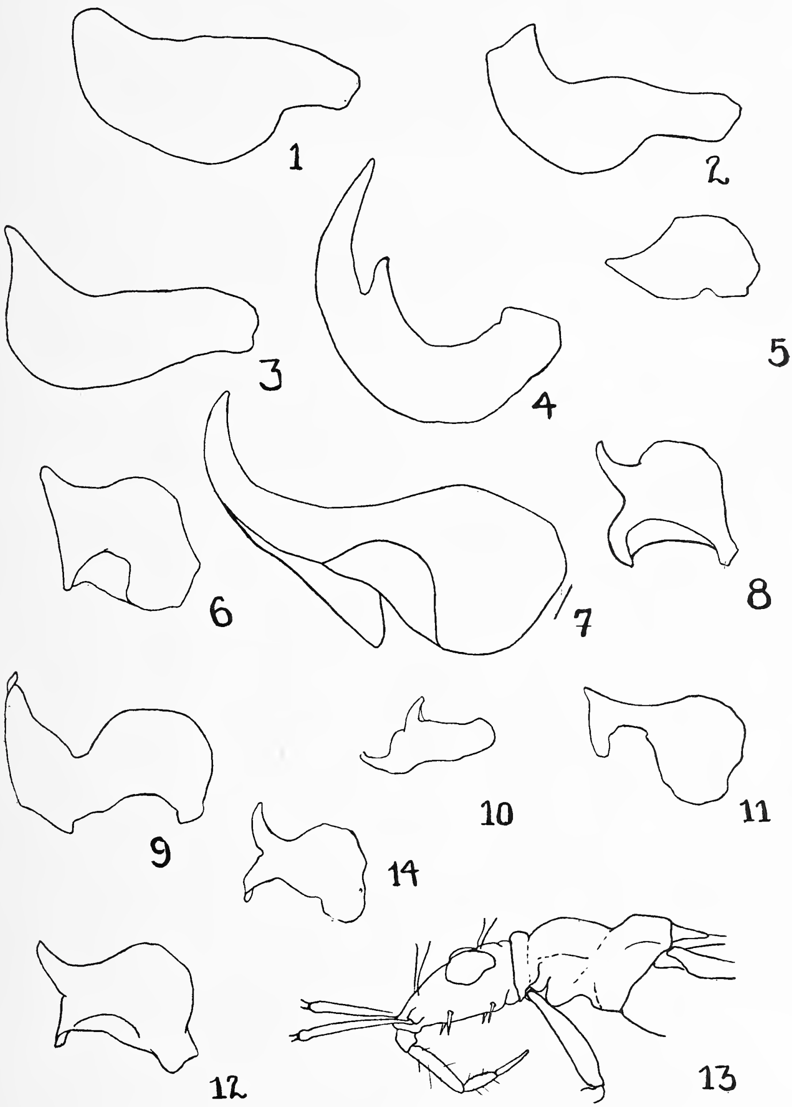
PLATE IV

FIG. 1. *Pagasa pallipes* Stål, male clasper.
FIG. 2. *P. luteiceps* (Walker), male clasper.
FIG. 3. *P. fusca* (Stein), male clasper.
FIG. 4. *Arachnocoris albomaculatus* Scott, male clasper.
FIG. 5. *Metatropiphorus drakei* n. sp., male clasper.
FIG. 6. *M. belfragii* Reut., male clasper.
FIG. 7. *Arachnocoris trinitatis* Bergroth, male clasper.
FIG. 8. *Carthasis minor* Reut., male clasper.
FIG. 9. *C. distinctus* Harris, male clasper.
FIG. 10. *Alloeorrhynchus trimacula* Stein, male clasper.
FIG. 11. *Carthasis uhleri* n. sp., male clasper.
FIG. 12. *C. decoratus* (Uhl.), male clasper.
FIG. 13. *C. minor* Reuter, head and thorax.
FIG. 14. *C. gracilis* Harris, male clasper.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ENTOMOLOGICA AMERICANA

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A REVISION OF THE GENUS EUREMA HÜBNER

(*LEPIDOPTERA, PIERIDAE*)

PART II, NEW WORLD SPECIES, TAXONOMY AND SYNONYMY

By Alexander Barrett Klots
ITHACA, N. Y.

INTRODUCTION

It seems superfluous to expound at any length the tangle into which the synonymy of the genus *Eurema* has lapsed, a thing self-evident to any one who has attempted any work upon it. Many of the species show a great capacity for both local and individual variation. This, taken in connection with the wide geographic range of the forms, makes any attempt at studying them without possessing large series of specimens from all parts of the range apt to result in the accomplishment of more harm than good. Most of the forms were, moreover, described in the days when entomologists believed, as some still do, that a form possessing any character whatsoever, no matter how slight, that differentiated it, was to be considered a species. Because of this any modern revision must necessarily contain a good deal of "lumping," when concerned with a group so thoroughly known to early Lepidopterists as was *Eurema*.

In view of this fact it seems advisable that the author's attitude toward the applicability of names to variations be defined. In the author's phylogenetic study of the New World species of *Eurema* (Jour. N. Y. Ent. Soc., Vol. XXXVI, March, 1928) the opinion was stated that the majority of the species of *Eurema* are of comparatively recent origin, and that minor variations, especially of color and pattern, must not be taken as possessing much significance. A careful study of still larger series of specimens has confirmed this opinion, with the result that a considerable number of names which have been applied to minor and individual variants are here placed in synonymy.

Species.

Numbers of so-called "species," though differing markedly from each other in coloration, less markedly always in pattern, prove to be so identical in less mutable characters that it is evident that they do not constitute different species at all. This is all the more marked by the presence of perfect series of intergrades which can be picked out in any collection of adequate size. It is, therefore, a bit of a question as to just where to draw the line regarding the right of a form to be considered as a distinct species. One thing is certain—since a species is an artificial grouping no generalization can possibly be made as to a definite limitation of the term which will necessarily hold true for any given group. In some groups the term may be made largely inclusive; in others it must be narrowly limited. In the New World species of *Eurema* it has seemed advisable to make the term "species" rather inclusive, as being the best way of emphasizing the relationships of the forms rather than their differences. The author may thus be considered more or less of a "lumper" as regards species, but as being perfectly willing to recognize the validity of any other form on reasonable grounds.

Subspecies.

Because of the present lack of knowledge regarding the life-histories of the species of *Eurema* no forms can definitely be placed as subspecies other than a number of geographic races. The author considers that an *altitude form,* representing really a geographic race in miniature, is worthy of being called a *subspecies.* Likewise a well-defined *seasonal form* or *food-plant form* might also be considered in the same class. However, too little biological data regarding practically all the species of *Eurema* are available for any definite conclusions of this sort to be drawn. In the present work, therefore, subspecific rank is awarded only to well-defined geographic races. In the check list these races are designated as (a), (b), etc.

Forms or Varieties.

Here are grouped all those variations which cannot be regarded as new species in process of differentiation and, therefore, cannot be classified as *subspecies.* Most *seasonal forms* are more or less inconstant; the chrysalis of one brood, by subjection to abnormal conditions, may be made to produce the typical form of the other brood; or one brood may produce, under normal conditions, some specimens of the other brood. These are surely not subspecific differences. Similar is the not directly inheritable variation of an individual. In some cases this variation is Mendelianly inheritable, as has been shown in the case of the white female form of *Eurymus philodice,* which can never breed true because of the presence of a balanced lethal. In other cases the variation of the individual is merely the result of abnormal exposures of the larva or pupa.

Many workers believe in applying a name to almost any variation from the normal. The fallacy of this proceeding is, I think, obvious. Since there is no limit to the number of individual variations possible, there is grave danger that the literature will become so clogged with a multiplicity of names that it will eventually fall of its own weight—thus defeating the primary purpose of our system of nomenclature. Some check must, therefore, be placed on the naming of variations. Because of the especially immense amount of individual variation in *Eurema* the author has adopted the following procedure:

(1) No variation is considered worthy of a name unless it is so markedly different from the typical form of the species that it is likely to be mistaken for another species.

(2) While the number of individual variations possible is unlimited, the number of possible lines of variation is small. Therefore, only one name is used to apply to each line of variation, and in accordance with the rules of priority this name is the one first applied to a variant on that line. All subsequent names applied on that line are placed as synonyms.

This does away, in part at least, with the senseless naming of a number of different specimens, all possessing the same type of variation from the normal, which is so encumbering our synonymy.

In the case of variations of frequent occurrence, which are suspected of being inheritable, the symbol "*f.*" is placed before the name of the variation. In the case of variations of infrequent or rare occurrence, which are probably not inheritable, the symbol "*ab.*" is prefixed to the name of the variation. Where the variation is limited to one sex the symbol of that sex is added to the prefix.

CHECK LIST, NEW WORLD SPECIES

EUREMA Hübner
Abaeis Hübner
Terias Swainson
Xanthidia Boisduval & Leconte
Pyrisitia Butler
Sphaenogona Butler
1. albula Cramer
cassiae Sepp
clara Bates
lirina Bates
melacheila Möschler
f. sinoe Godart
marginella Felder
f. tapeina Bates
celata R. Felder
leucilla R. Felder
2. reticulata Butler
doris Röber
marmorata Dognin
3. deva Doubleday
agave Fabricius
agavoides Wellengren
fabricia Poey
(a) chilensis Blanchard
4. pseudomorpha Klots
5. lucina Poey
arabella Lucas
f. fornsi Poey
conjungens Herrich Schaeffer
6. priddyi Lathy
(a) forbesi Klots
7. jucunda Boisduval & Leconte
f. ♀ pallidula Klots
f. sidonia Felder
8. nigrocincta Dognin
ella Röber
9. palmyra Poey
cubana Herrich Schaffer
albina Poey

(a) lydia Felder
lemnia Felder
10. daira Godart
cepio Godman & Salvin
delia Cramer
demoditas Hübner
(a) eugenia Wallengren
solana Reakirt
rhodia Felder
persistens Butler & Druce
(b) ebriola Poey
11. elathea Cramer
midea Menetries
ab. venilia D'Almeida
f. flavescens Chavannes
vitellina Felder
elathides Staudinger
f. mycale Felder
f. tegea Felder
f. medutina Felder
phoenicia Felder
plataea Felder
12. agave Cramer
jodutta Hübner
mana Boisduval
pallida Chavannes
(a) sinoides Capronnier
13. phiale Cramer
gentilis Boisduval
musa Fabricius
singularis D'Almeida
paula Röber
(a) columbia Felder
14. pyro Godart
f. hyona Menetriés
15. messalina Fabricius
blakei Maynard
bulaea Boisduval
gnathene Boisduval
gnatheme auct.
iradia Poey
16. portoricensis DeWitz
tenera Avinoff
17. nicippe Cramer
f. ♀ flava Strecker

18. adamsi Lathy
19. ecuadora Hewitson
20. gratiosa Doubleday & Hewitson
    theona Felder
21. boisduvaliana Felder
    gratiosa Rerkirt
    ingrata R. Felder
22. arbela Hübner
    theodes Felder (in part)
    boliviensis Röber
    ectriva Butler
        (a) graduata Butler
    gracilis Avinoff
    semiflava Butler
        (b) elsia Klots
23. xanthochlora Kollar
    constantia Felder
    paulina Bates
        (a) pomponia Hopffer
    sybaris Hopffer
        f. ♀ marjoria Klots
24. mexicana Boisduval
    damaris Felder
    depuiseti Boisduval
        ab. biedermanni Ehrmann
    henrici Maria
        ab. recta Klots
        (a) bogotana Felder
    chloe Felder
25. salome Felder
        f. limoneus Felder
    gaugamela Felder
    jamapa Reakit
        f. fabiola Felder
26. amelia Poey
27. proterpia Fabricius
        (a) watsonia Klots
28. gundlachia Poey
    longicauda Bates
        f. ♀ alba Maria
29. lisa Boisduval & Leconte
    stygmula Boisduval
    thymetus auct. (nec Fabricius)
    similar auct. (nec Donovan, nec Godart)
        f. clappi Maynard
        f. ♀ alba Strecker

centralis Herrich Schaffer
(a) euterpe Menetriés
sulphurina Poey
30. dina Poey
dina Geyer
f. ♀ citrina Poey
larae Herrich Schaffer
f. memulus Butler
(a) westwoodi Boisduval
calceolaria Butler & Druce
(b) parvumbra Kaye
(c) leuce Boisduval
athalia Felder
circumcincta Bates
diodina Butler
flavilla Bates
hahneli Staudinger
thymetus auct. (nec Fabricius)
31. chamberlaini Butler
32. nise Cramer
floscula Weeks
lepidula D'Almeida
neda Godart
panopea D'Almeida
thymetus auct. (nec Fabricius)
tenella Boisduval
nisella Felder
sulla Weymer
germana D'Almeida
jacarepaguana D'Almeida
ab. alcides D'Almeida
(a) stygma Boisduval
cordobensis Kohler
(b) perimede Prittwitz
linda Edwards
nelphe Felder
venustula Staudinger
33. venusta Boisduval
aequatorialis Felder
diosa Moschler
(a) limbia Felder

Old World Species of EUREMA *described or cited as of New World Occurrence*

aesiope Menetries
hecabeoides Menetries

jaegeri Menetries
[1] smilacina Felder
Forms of Teriocolias described in Eurema
atinas Hewitson
flavia Burmeister
zelia Lucas
Forms of Leucidia described in Eurema
brephos Hübner
elvina Godart
impura Vollenhoven
leucoma Bates
Names still in doubt
arabella Hübner
deflorata Kollar

ARTIFICIAL KEY TO NEW WORLD SPECIES AND FORMS OF *Eurema*

1. Outer angle of secondaries tailed or angulate 2
1. Outer angle of secondaries rounded 26
2. Ground color of wings above orange 3
2. Ground color of wings above not orange 7
3. Secondaries distinctly tailed at outer angle; beneath apices of primaries and all of secondaries with heavy brown reticulations and broken wavy bars .... *gundlachia* both sexes
3. Secondaries with outer angle obtusely angulate; predominating color of secondaries and apices of primaries beneath yellow to light orange 4
4. Males 5
4. Females 6
5. Outer margin of wings above lightly or not at all clouded with fuscous; entire cubital system (including M_3) and 2d A of primaries above, and all veins of secondaries above never heavily black for proximal $\frac{2}{3}$; color a medium orange .... *proterpia proterpia* ♂

[1] Mr. N. D. Riley has examined the type of *smilacina* and assures me that it is a ♀ of *floricola* Boisduval, described from Madagascar and Mauritius.

5. Outer margin of wings above heavily clouded with fuscous; above-named veins black for entire length above; color intense orange; Ecuador .... *proterpia watsonia* ♂
6. Secondaries with a heavy black border, diffuse internally, extending almost to 2d A; entire surface of wings above lightly dusted with black scales; Ecuador .... *proterpia watsonia* ♀
6. Border of secondaries above narrow or absent, extending little if any beyond Cu_1; no fuscous dusting on wings above .... *proterpia proterpia* ♀
7. Both wings above with ground color yellow 8
7. Both wings above not yellow 16
8. Secondaries beneath reticulated with ochraceous. See Note 1 at end of key 9
8. Secondaries beneath reticulated with reddish or fuscous 11
9. Border of secondaries wide, heavily toothed or undulate internally .... *salome* f. *limoneus* ♂
9. Border of secondaries above narrow and very lightly undulate internally, or absent 10
10. Border of secondaries extending unbroken beyond Cu_2 .... *salome* f. *salome* ♂
10. Border of secondaries much reduced or absent, not extending unbroken beyond M_2 .... *salome* f. *fabiola* ♂
11. Border of secondaries above very wide and irregular internally .... *boisduvaliana* ♂
11. Border of secondaries above narrow or absent; when present may be lightly and evenly scalloped internally 12
12. Males 13
12. Females 15
13. Secondaries beneath with the following: a reddish or fuscous spot on costa at tip of $Sc + R_1$;

a broad reddish smear, pointed internally, running in and down from outer margin below apex, pointing at a reddish or fuscous spot beneath Cu_2 and 2d A; various reddish fuscous reticulations; border of secondaries above always fairly wide .... *arbela arbela* ♂

13. Spot on costa at tip of $Sc + R_1$ of secondaries beneath rarely reddish, usually fuscous; never any red smear as in *arbela*; border of secondaries above usually reduced, when wide the border of the primaries above is not squarely emarginate between M_3 and Cu_1 14
14. Border of secondaries much reduced or absent .... *xanthochlora xanthochlora* ♂
14. Border of secondaries wide, extending to Cu_2; Peru .... *xanthochlora pomponia* ♂
15. Size medium or small; Central America. See Note 2 at end of key .... *boisduvaliana* ♀
15. Size larger; Peru .... *xanthochlora pomponia* ♀
16. Ground color of both wings above the same 17
16. Primaries yellow, secondaries white 25a
17. Males 18
17. Females 23
18. Secondaries above with orange near apex 19
18. Secondaries above with no orange .... *mexicana bogotana* ♂
19. Black border of primaries above beginning on costa about at tip of R_3, borders of both wings very wide, that of secondaries abruptly truncate at Cu .... *ecuadora* ♂
19. Black border of primaries above beginning on costa basad of the tip of R_1 20
20. Border of secondaries above narrow, smooth or lightly scal-

loped internally, extending beyond outer angle .... *arbela elsia* ♂

20. Border of secondaries very wide between M_1 and M_2 or M_1 and M_3, very irregular inside, often stopping at M_3; orange on secondaries above extending to base of costa, widely suffused 21

21. Emargination of border of primaries between M_2 and M_3 or M_2 and Cu_1 deep, narrow, hooked downward 22

21. Emargination of border of primaries broad, square, never hooked downward .... *mexicana* ab. *recta*

22. Emargination of border of primaries tending to be cut off at inner margin of border, leaving the distal portion of the emargination as an isolated white patch in the border .... *mexicana* ab. *biedermanni*

22. Emargination of border of primaries uninterrupted at inner margin of border .... *mexicana mexicana* ♂

23. Border of primaries extending broadly to inner margin of wing, deeply emarginate between M_3 and Cu_2; secondaries beneath lightly reticulated and smeared with red .... *mexicana mexicana* ♀

23. Border of primaries narrowing greatly to inner margin of wing, or not reaching inner margin 24a

24a. Border of primaries above not reaching inner margin of wing, stopping short at Cu_2; secondaries beneath lightly smeared with red; outer angle of secondaries angulate or shortly tailed 24b

24a. Border of primaries above reaching inner margin of wing; secondaries beneath heavily

reticulated and smeared with red; outer angle of secondaries well tailed .... *mexicana bogotana* ♀
24b. Size larger; Peru .... *xanthochlora* f. ♀ *marjoria*
24b. Size smaller; Panama, Colombia, Venezuela, Brazil .... *gratiosa* ♀
25a. Border of secondaries above absent or reduced to patches at the ends of the veins; females .... *gratiosa* ♀
25a. Border of secondaries above unbroken before Cu_2; males 25b
25b. Border of secondaries above narrow, very lightly undulate internally .... *arbela graduata* ♂
25b. Border of secondaries above wide, extending deeply into wing between M_2 and M_3, below that irregularly toothed or crenate .... *gratiosa* ♂
26. R_2 shortly stalked on $R_3 + R_{4+5}$ .... *amelia*
26. R_2 arising from cell 27
27. Ground color of primaries above orange 28
27. Ground color of primaries above not orange 30
28. Primaries above with discocellular spot; black border of wings above very heavy and irregular internally .... *nicippe* (See Note 5)
28. Primaries above with no discocellular spot; black border of wings above narrow and always fairly smooth internally 29a
29a. Lower discocellular of secondary more than three times as long as middle discocellular; border of secondary above fairly wide 29b
29a. Lower discocellular of secondary never more than twice as long as middle discocellular; border of secondary above absent or reduced to a narrow marginal line .... *dina* f. *memulus*
29b. Secondaries above with basal half or two-thirds yellow; re-

mainder of wing orange with black border........*pyro* f. *hyona* ♂

29b. Secondaries above with whole disc of wing orange........*pyro* f. *pyro* ♂

30. Primaries with a black or dark gray bar, just above and parallel to inner margin, extending from base toward outer margin........31

30. Primaries with no such bar; see Note 3 at end of key........45

31. Bar black, narrow, straight, definitely touching inner margin at base, never with long gray hairs........32

31. Bar gray, often broad and arched, touching inner margin very shortly at base if at all, with long gray hairs on basal third or half........36

32. Bar fusing with outer border........*elathea* f. *mycale* ♂

32. Bar not reaching outer border........33

33. Secondaries beneath with red, red-brown or red-ochraceous suffusion or markings........34

33. Secondaries beneath with no suffusion or markings other than yellowish, gray or black........35

34. From West Indian islands (not including Trinidad)........*elathea* f. *elathea* ♂

34. From mainland Central or South America and Trinidad........*elathea* f. *flavescens* ♂

35. Border of secondaries above broad, ending abruptly in region of tip of Cu_2; primaries beneath with whole disc usually suffused with yellow........*elathea* f. *tegea* ♂

35. Border of secondaries above narrow, toothed internally, tapering to end; primaries beneath with yellow usually limited to a narrow patch in cell and a small subapical patch........*elathea* f. *medutina* ♂

36. Color of both wings above yellow........37

36. Color of both wings above white...40
36. Color of primaries above yellow, secondaries white...43
37. Submarginal bar of primaries above completely fused with outer border; primaries more pointed; Ecuador...*nigrocincta* ♂
37. Submarginal bar of primaries above not reaching outer margin or (rarely) barely reaching it in part; apex of primaries more rounded; Central and southern North America...38
38. Marginal border of secondaries above extending beyond Cu_1, never limited to an apical patch...39
38. Marginal border of secondaries above limited to an apical patch, extending little beyond M_1...*daira daira* ♂
39. Marginal border of secondaries wide, diffuse internally, extending beyond anal angle; inside border and in costal and anal regions wing is rather thickly dusted with fuscous scales...*jucunda sidonia*
39. Marginal border of secondaries narrower, not exceeding anal angle unbroken; little fuscous dusting on secondary; See Note 4 at end of key...*jucunda jucunda*
40. Marginal border of primaries beginning abruptly on costa, except for a narrow line, well beyond the middle; fuscous shading along base of costa never wholly reaching marginal border...41
40. Marginal border of primaries beginning gradually on costa, at or basad of middle; fuscous shading along costa from base confluent with marginal border; females...*jucunda* f. ♂ *pallidula*

41. Marginal border of secondaries extending to Cu_2 .... *lucina* f. *fornsi* ♂
41. Marginal border of secondaries obsolescent at M_3 .... *lucina* f. *lucina* ♂
42. Marginal border of secondaries broad, extending unbroken to at least Cu_1, often to Cu_2; secondaries beneath pearly white, sometimes dusted with fuscous, never with any red or red-brown 43
42. Marginal border of secondaries consisting of an apical patch, stopping about halfway between M_1 and M_2, beyond that broken and very narrow; secondaries beneath with red-brown or yellowish-brown suffusion and a darker submarginal wavy broken bar 44
43. Submarginal bar of primaries broad; considerable fuscous shading along base of R on secondaries above; Central America .... *palmyra lydia* ♂
43. Submarginal bar of primaries narrow; very little fuscous shading along base of R on secondaries above; West Indies .... *palmyra palmyra* ♂
44. Submarginal bar of primaries narrow; apical patch on secondaries usually small; West Indies .... *daira ebriola* ♂
44. Submarginal bar of primaries wide; apical patch of secondaries large; Central and northern South America .... *daira eugenia* ♂
45. Primaries yellow, secondaries pure white 46
45. Both primaries and secondaries white 47
45. Both primaries and secondaries yellow 60
46. Primaries above with fuscous shading along costa which

runs into the heavy marginal border; secondaries beneath reddish or yellowish brown .... *elathea* ab. ♂ *venilia*

46. Fuscous shading on costa not confluent with marginal border; secondaries beneath white or yellowish with no reddish or brown markings .... *venusta* f. *limbia*

47. Primaries above with a fuscous line at end of cell, sometimes faint; females .... *lisa* f. ♀ *alba*

47. Primaries above with no markings at end of cell 48

48. Secondaries above with no black marginal border or patches 49

48. Secondaries above with a black marginal border, sometimes limited to an apical patch or broken into patches 54

49. Secondaries above with a yellow marginal border .... *phiale columbia*

49. Secondaries above immaculate 50

50. Primaries beneath with a blackish subapical submarginal spot; secondaries beneath with a large purplish or pink apical patch .... *messalina* ♀

50. Wings beneath without the above markings 51

51. Primaries beneath with a heavy discocellular dot; apex of primaries rather pointed; secondaries beneath ochraceous with a reddish spot on costa just before apex and various reddish reticulations and dots .... *adamsi* ♀

51. Without the above combination of characters 52

52. Apex of primaries rounded, outer margin strongly curved; a broad fuscous shading along basal half of costa above; marginal border of primaries beginning abruptly on costa .... *agave sinoides*

52. Without the above combination of characters 53

53. Marginal border of primaries little reduced; apex of primaries and whole of secondaries beneath white or faintly yellowish, rarely with faint markings .... *albula* f. *albula*
53. Marginal border of primaries much reduced; apex of primaries and whole of secondaries beneath ochraceous yellow with strong markings .... *albula* f. *tapeina*
54. Secondaries above with submarginal yellow border .... *phiale phiale*
54. Secondaries above with no yellow 55
55. Primaries beneath with a prominent discocellular dot 56
55. Primaries beneath with no discocellular dot 57
56. Marginal border of primaries above reaching inner margin .... *adamsi* ♂
56. Marginal border of primaries above stepping short at Cu_2 .... *priddyi forbesi*
57. Primaries above with a broad shading of gray scales along costa from base to beyond end of cell .... *agave agave*
57. Primaries above with gray shading along costa, if present, limited to the basal quarter 58
58. A subapical submarginal dark spot on both primaries and secondaries beneath; apices of primaries and whole of secondaries beneath yellowish 59
58. Primaries and secondaries beneath pearly white except for a lemon yellow area at base of costa of primaries .... *albula* f. *sinoe*
59. Marginal border of secondaries above narrow and extending unbroken from apex to beyond Cu_1 .... *messalina* ♂
59. Marginal border of secondaries above reduced to an apical

patch and a small dot at the end of each vein .... *messalina* ♀

60. Primaries above with a discocellular dot 61
60. Primaries above with no discocellular dot 65
61. Middle discocellular of secondaries straight, nearly continuous in a straight line with M_2 .... *nicippe* f. ♀ *flava*
61. Middle discocellular of secondaries decidedly curved, forming an angle of about 30° with M_2 62
62. Males 63
62. Females .... *lisa* all forms
63. Secondaries above with a well-defined marginal border extending unbroken to at least Cu_1 64
63. Marginal border of secondaries above limited to an apical patch, beyond that broken and obsolescent .... *lisa* f. *clappi*
64. Marginal border of secondaries above fairly heavy; secondaries and apices of primaries beneath of a deeper yellow than disc of primaries and clouded with fuscous scaling; a fairly heavy pinkish-red apical spot on secondaries beneath; North America .... *lisa lisa*
64. Border of secondaries above narrow; coloring beneath less intense; West Indies and Central America .... *lisa euterpe*
65. Primaries beneath with a subapical submarginal dark spot; secondaries beneath with a preapical dark spot on costa, a reddish apical patch which is bounded basally by a dark line, and inside and below this a dark spot; Porto Rico .... *portoricensis*
65. Without the above combination of characters 66

66. Border of primaries above limited to a triangular apical patch; primaries beneath with no discocellular dot; secondaries beneath clear yellow with well defined red spots 67
66. Without the above combination of characters 70
67. Largest red spot on secondaries beneath is marginal, between the tips of R_s and M_1, or R_s and M_2 ..... *nise stygma*
67. Largest red spot on secondaries beneath is submarginal or on costa basad of tip of $Sc + R_1$ 68
68. Apical border of primaries above beginning on costa at or beyond tip of R_1 and ending on outer margin at tip of Cu_1; secondaries beneath with a small reddish spot in cell near base and two other small reddish spots, basad of this and above and below the cell, forming with the spot in the cell an isosceles triangle; heaviest red spot on secondaries beneath located on costa basad of tip of $Sc + R_1$ 69
68. Apical border of primaries above beginning on costa at tip of Sc and extending on outer margin to tip of Cu_2; secondaries beneath sometimes with the small reddish spot in cell near base but never with the two other spots basad of this and above and below the cell forming with the spot in the cell an isosceles triangle; heaviest red spot on secondaries beneath located submarginally between M_1 and M_2 ..... *pseudomorpha*
69. Smaller; apical border of primaries reduced; reddish spots

on secondaries beneath obsolescent; Chile .... *deva chilensis*

69. Larger; apical border of primaries heavy; red spots on secondaries beneath deep .... *deva deva*

70. Marginal border of primaries above not exceeding Cu_2 on outer margin 71

70. Marginal border of primaries above exceeding Cu_2 on outer margin 74

71. Marginal border of primaries above abruptly truncate at Cu_2; secondaries beneath clouded with fuscous scales and with a broken wavy submarginal bar of fuscous scales; Haiti .... *priddyi priddyi*

71. Marginal border of primaries above tapering gradually to end; secondaries beneath without clouding of fuscous scales 72

72. Primaries beneath with no discocellular dot; Jamaica .... *dina parvumbra*

72. Primaries beneath with a discocellular dot 73

73. Secondaries above yellow with distinct apical orange shading; secondaries beneath yellow with largest reddish spot at margin below tip of R_s .... *dina* f. ♀ *citrina* (lightly marked specimens)

73. Secondaries above orange yellow, no more deeply colored at apex; secondaries beneath ochraceous, thickly reticulated with reddish; largest spot on secondaries beneath located internally below cell and between Cu and 2d A .... *reticulata*

74. Primaries above distinctly deeper yellow than secondaries above .... *venusta* f. *venusta*

74. Primaries above no deeper in color than secondaries above 75

75. Both primaries and secondaries above yellow suffused with

orange; size large; Central America and (?) southern North America .... *dina westwoodi*

75. Orange suffusion above, if present, limited to secondaries 76
76. No orange suffusion on secondaries above 78
76. Secondaries above suffused with orange 77
77. Orange suffusion on secondaries above sharply limited to an apical patch; females; Cuba .... *dina* f. ♀ *citrina*
77. Orange suffusion on secondaries above not sharply limited to an apical patch; both sexes .... *dina dina*
78. Size large, length of primary about 22 mm.; wings in general broader with outer margin of primary straighter and inner edges of marginal border of primaries above more deeply scalloped .... *dina leuce*
78. Size smaller, length of primary about 18 mm. or less; wings in general narrower with outer margin of primary more convex and inner edge of marginal border of primaries above smoother 79
79. Marginal border of primaries above greatly reduced; Jamaica .... *dina parvumbra*
79. Marginal border of primary above not usually strongly narrowed; Central and South America 80
80. Primaries beneath with a discocellular dot at upper end of cell; Central America .... *nise perimede*
80. Primaries beneath with no discocellular dot; South America .... *nise nise*

Notes to Key

1. The author cannot find any character by which to separate the females of any of the *salome* forms. Accordingly only the males have been included in the key.

2. Except for size the females of *boisduvaliana* and *xanthochlora* are indistinguishable. Fortunately the ranges of the species do not overlap. White females of *xanthochlora* occur to which the author has applied a name because of their similarity to females of *gratiosa*. See under description and discussion of *xanthochlora* following.

3. The females of all of the barred species excepting *jucunda* are exceedingly hard to separate, and have not been included in the key. There is no satisfactory character to separate them as a group. The black dusting on the base of the primaries above extends further distad below 2d A than above it. For the general appearance of these females see Figs. 15, 18 and 20. They may usually be specifically determined by comparison with males from the same locality, keeping in mind the fact that the females usually have the markings and coloring on the under side more intense than do the males.

4. *Jucunda* and *sidonia* show a good deal of intergrading so that intermediates occasionally occur which cannot be definitely identified as either form.

5. Females of *pyro* have a somewhat diffuse discocellular dot on the primaries above. They may be easily separated from *nicippe* by the smaller size, the even inner edge of the marginal borders and the range, which is probably limited to the island of Haiti.

Eurema Hübner

Hübner proposes the generic name *Eurema* in the Verzeichniss Bekannte Schmettlinge, on p. 97. As it is known that the Verzeichniss was not issued as a whole, but by signatures, the date on the title page, 1816, is not applicable to the whole volume. The signatures of the Verzeichniss were of 16 pages, so that *Eurema* is in the 7th. The weight of evidence seems at present to incline toward placing the date of issue of the 6th to the 11th signatures as 1820. It is, therefore, most likely that *Eurema* antedates *Terias* Swainson, Zool. Ill., I, t. 22, 1820–21, which is itself of rather uncertain date.

Eurema Hübner is not to be confused with *Eurema* Doubleday, Gen. Diurn. Lep., p. 192, 1848, which is a synonym of *Hypanartia* Hübner.

The author, having studied carefully the structures of *Eurema*, does not consider that any subgenera are warranted. If there were need of any such *E. amelia* Poey is the only species which could reasonably be separated from the others, having as it does R_2 stalked on $R_3 + R_{4+5}$. Therefore, *Abaeis* Hübner, *Xanthidia* Boisduval and

Leconte, *Pyrisitia* Butler and *Sphaenogona* Butler are placed in synonymy. There is more need for a separation of the Old World species from the New World ones than for splittings in the latter.

1. *albula* Cramer, Pl. II, Fig. 32, upper side, male.
   f. *sinoe* Godart. Not figured.
   f. *tapeina* Bates, Pl. II, Fig. 35a, under side, male, Fig. 35b, upper side.

Albula shows great variation among individuals from the same locality—so much so that the author has not even placed *sinoe* and *tapeina* as subspecies, much less as distinct species. The forms are all identical genitalically, and are distinct from anything else. The author has examined perfect series of intergrades between *albula* and *sinoe* from the following localities: *Peru*: El Campamento, Chanchamayo distr., Putumayo distr., Puerto Bermudez, Rio Pichis; *British Guiana*: Tumatumari; *Surinam*: Kwakoegron-Saramacca R.; *Brazil*: Teffé, Obidos, Pará. *French Guiana.* Specimens of *sinoe* alone are known to the author from Kartabo, British Guiana and Trinidad. In both these localities there is considerable variation, some specimens possessing only a very narrow border on the secondaries. Whatever the causative factor in the formation of *sinoe* may be, it does not appear to be rigidly geographic or seasonal.

In his description of *sinoe* Godart refers to a narrow black border on the secondaries of some specimens which others lack. This is sufficient to fix the name and accordingly *marginella* Felder must be placed as a synonym.

Leucilla R. Felder and *celata* R. Felder refer to specimens of *tapeina* from Mexico. Intergrade series between *albula* and *tapeina* are in the author's collection from Sao Paulo and Paysandú, Brazil. He has seen specimens of *tapeina* from no localities other than Mexico and Southern Brazil. The occurrence of the form from both the northern and southern limits of the range of *albula* is significant, inasmuch as it appears to be missing in the tropical part. It may, therefore, represent a temperate climate race, in which case it would certainly be worthy of the designation of subspecies. For the present, however, it is merely placed as a form, because of insufficiency of material.

Clara Bates and *lirina* Bates represent merely specimens of *albula,* slightly smaller in size, in which the black marginal border of the primaries has been somewhat reduced.

2. *reticulata* Butler, Pl. II, fig. 46, upper side, male.

Reticulata is a very distinct species, and one that somehow does not look as if it belonged in *Eurema,* although it agrees well structurally with the other species. *Marmorata* Dognin from Ecuador is undoubtedly a synonym. I suspect that *doris* Röber is nothing more than the female, which is unknown to me, inasmuch as its greater size, more diffuse marginal border and more intense markings and coloring beneath are all characteristics in which female *Euremas* usually vary from the males.

3. *deva* Doubleday, Pl. II, fig. 44, upper side, male.
   (a) *chilensis* Blanchard, Pl. II, fig. 45, upper side, male.

This species was originally described as *Papilio agave* by Fabricius in 1793. The name was preoccupied by *Papilio agave* Cramer of 1775, so that *deva* Doubleday, the first substitute name proposed, is valid. *Agavoides* Wallengren and *fabricia* Poey are substitute names subsequently proposed. This species is quite constant over most of its range. *Chilensis* Blanchard is, however, a valid geographic race from Chile.

4. **Eurema pseudomorpha** new species.
   Pl. II, fig. 34, upper side, holotype male.
   Pl. IV, fig. 101, under side, holotype male.

The confusion arising from the use of the name *thymetus* Fabricius for several different species of *Eurema* as well as for a species of *Phyciodes* (*Nymphalidae*) and for a species of *Tyndaris* (*Callidulidae*), has resulted in the fact that this species has been overlooked, being considered as *thymetus.* It seems time to attempt to settle what *thymetus* Fabricius really is. The description is exceedingly vague, but inasmuch as the species is described in the *Nymphalidae* and between *lucindus* and *morpheus,* both of which are well recognized *Phyciodes,* the theory that *thymetus* Fabr. is a *Phyciodes* appears well grounded. Röber (Seitz, Macrolep. V, I, p. 435) states that it is probably a feebly marked form of *P. liriope* Cramer, which seems probable. At any rate it certainly does not belong in *Eurema.*

The present author made the same mistake. In his paper on the phylogeny of the New World species of *Eurema* he referred to this species as *thymetus* Fabricius.

Length of primary from base of costa to apex, 25 mm. Upper side of both wings lemon-yellow. Primary with a brownish black border which begins on costa slightly basad of the tip of Sc and extends on outer margin to the tip of Cu_2. Secondary immaculate except for a small brownish black dot at the end of each vein except 2d A. Anal area of secondary above slightly lighter in color than the rest of wing.

Primary beneath slightly deeper yellow than above. Base of wing as far as cell suffused with deep yellow or light orange. Inner margin lighter yellow than rest of wing. Edge of wing from tip of R_1 to tip of Cu_2 with a narrow red line.

Secondary beneath deeper yellow than primary, with spots as shown in Pl. IV, fig. 101, bright cherry red.

Venation of primary normal as in other species of *Eurema.* On the secondary R_s and M_1 are connate from the cell and the lower discocellular is almost straight and about half again as long as the middle one.

Male genitalia. Practically identical with the genitalia of any of the "barred" species of *Eurema.* Uncus long, slender, slightly curved. Valve pointed, with lobes as follows: Lobe *a,* internal, arising equidistant from dorsal edge and base, long, slender, pointed, strongly recurved. *Distal process* arising ventrally from tip of valve, flat, triangular, pointed. Lobe *e* arising equidistant from dorsal and ventral edges of valve near tip, inclined ventrad, somewhat bent and broader at tip, bluntly pointed.

Holotype male, Bolivia, S. A., no. I. C. M. 1100 in collection of Academy of Natural Sciences, Philadelphia, Pa.

5. *lucina* Poey, Pl. I, fig. 1, upper side, male.
   (a) *fornsi* Poey, Pl. I, fig. 2, upper side, male.

It is probable that *lucina* and *fornsi* represent merely pattern forms of one species. Both are limited to Cuba, occurring there in the same localities at the same season. They differ only in the extent of the black marginal border of the secondaries, and to a great degree intergrade. Genitalically they are identical, not only with each other but also with the closely related *priddyi* Lathy from Haiti and Cuba. *Arabella* Lucas is evidently a synonym of *lucina. Conjungens* Herrich Schaffer is merely a large *fornsi* female with somewhat heavy borders.

6. *priddyi* Lathy, Pl. I, fig. 3, upper side, female.
   (a) *forbesi* new subspecies, Pl. I, fig. 4, paratype ♂, upper side.
   Pl. I, fig. 5a, holotype ♂, under side.
   Pl. I, fig. 5b, holotype ♂, upper side.

Limited to Haiti, and very different from *lucina* in that the ground color is yellow instead of white, and in that the males lack all trace of the suffused submarginal bar on the primaries, *priddyi* is evidently a distinct species, in spite of being genitalically identical with *lucina*. In Cuba occurs a hitherto undescribed race of *priddyi*, to which the author applies the name of *forbesi*.

Eurema priddyi **forbesi**, new subspecies.
Pl. I, fig. 4, paratype ♂, upper side.
Pl. I, fig. 5a, holotype ♂, under side.
Pl. I, fig. 5b, holotype ♂, upper side.

♂. Average length of primary, measured from base of costa to apex, 13.5 mm. Ground color of wings above white or yellowish white, thus differing from *priddyi priddyi* in which the ground color is a bright yellow. Border of both wings above brownish black, that of primaries showing little variation, that of secondaries varying considerably in extent, as shown in figs. 4 and 5b.

Primary beneath pearly white. Costal cell pinkish brown. A shading of yellow, dusted with fuscous scales, along costa, broad basally, narrower toward apex. Apex with a similar shading covering the same area as the marginal border above. The fuscous scales concentrated into a diffuse subapical submarginal spot. An elongate blackish brown spot at end of cell. Inner margin with pearly sex-scaling below 2d A, extending to outer margin.

Secondary beneath light yellow, thickly dusted with brown and fuscous scales. These are concentrated to form a submarginal broken wavy band.

Male genitalia identical with those of *lucina* and *priddyi priddyi*.

Holotype male, Isle of Pines, Cuba, in collection American Museum of Natural History, New York City, N. Y.

Paratype male, Isle of Pines, Cuba, in collection U. S. National Museum.

Paratype male, Isle of Pines, Cuba, in author's collection.

I take pleasure in naming this race for Dr. W. T. M. Forbes, of Cornell University.

7. *jucunda* Boisduval, Pl. I, fig. 6, upper side, male.
Pl. I, fig. 7, upper side, female.
f. ♀ **pallidula**, new form, Pl. I, fig. 8, upper side, female.
f. *sidonia* Felder, Pl. I, fig. 9, upper side, male.

After studying a large series of specimens the author has come to the conclusion that *sidonia* Felder is best placed as a form of *jucunda*. The transition from *jucunda* to *sidonia* is merely a case of the suffusion into the disc of the wing of the marginal border of the secondaries, and a corresponding general increase in extent of the fuscous markings. The author possesses an excellent series of intergrades between the two forms. Probably they represent geographic races in process of formation, *jucunda* occurring throughout the southern United States and Mexico while *sidonia*, occurring no further north than Mexico, ranges southward through part of Central America. Because of this great overlap in range, taking in all of Mexico, the author does not consider that *sidonia* can be placed as a race of *jucunda*. *Ella* Röber, described as a form of *sidonia* from Ecuador, is evidently more applicable to the following species, *nigrocincta* Dognin.

White females of *jucunda* occur. These have been confused with *lucina* and with *elathea* females by various authors.

Eurema jucunda f. ♀ **pallidula** new form, Pl. I, fig. 8, upper side.

Differing from typical *jucunda* females in the following particulars:

(a) Ground color of upper side of wings white instead of light yellow.

(b) Primaries beneath with less yellow shading basally.

(c) The gray bar above and parallel to the inner margin of the primaries above shows more tendency to reduction.

Holotype female, Barrios, Guatemala, Dec. 18, 1912, in collection American Museum of Natural History, New York City, N. Y.

Five paratype females, various localities in Mexico and Guatemala, deposited as follows: one in British Museum, one in Hill Museum, Witley, Surrey, England, one in collection Cornell University, Ithaca, N. Y., one in United States National Museum, Washington, D. C., one in author's collection.

8. *nigrocincta* Dognin, Pl. I, fig. 10, copied from Plate 3, fig. 6 of author in Notes sur la Faune des Lepidopteres de Loja et environs, (Equateur) P. Dognin, Paris, 1887.

Nigrocincta from Ecuador and Peru is an exceedingly rare species, two males in the U. S. National Museum, one of which is the type, being the only specimens in the United States of whose existence I am aware. It evidently represents a form, differentiated originally as a race of *jucunda* or *sidonia*, which now constitutes a distinct species. *Ella* Röber, described as a form of *sidonia* from Ecuador, probably is applicable as a synonym of *nigrocincta.*

9. *palmyra* Poey, Pl. I, fig. 11, upper side, male.
   (a) *lydia* Felder, Pl. I, figs. 12 & 13, upper sides, males.

Palmyra is evidently very closely related to *jucunda,* inasmuch as many males of both *p. palmyra* and *p. lydia* are identical with *jucunda* males except for the white secondaries. The writer has considered the possibility that *palmyra* could, in fact, very well be placed as a race of *jucunda.* However, when we regard *nigrocincta* as a *jucunda* derivative, as it undoubtedly is, the ranges of the two forms overlap from Central Mexico to Peru, and only in Northern and Western Mexico and the Southern United States is *jucunda* found alone. Therefore, *palmyra* is placed as a distinct species, with the reservation that it is exceedingly closely related to *jucunda.*

Palmyra occurs commonly in Cuba, the type locality, and in most of the Antilles. *Lydia* represents a mainland race, ranging from Mexico to Brazil. Many specimens of *lydia,* however, from Honduras, Panama and Ecuador are not essentially different from typical specimens of *p. palmyra* from Cuba. While *lydia* is here placed as a race of *palmyra,* it, therefore, cannot be considered as a very distinct one. *Lemnia* Felder, described from Brazil, merely represents a *lydia* with a slight tinge of yellow on the secondaries, a character insufficient to validate the name, especially as many specimens from Brazil show no trace of this yellow.

Two lines of variation are evident in both *p. palmyra* and *p. lydia* regarding the width and extent of the black marginal border of the secondaries above, as is shown in the two specimens of *p. lydia* figured. Both variations occur in specimens taken flying together, so that they may be regarded as merely individual. In the course of time these variations may, of course, increase and stabilize. They are noted here mainly because transitionals between the two types are rare.

10. *daira* Godart, Pl. I, fig. 14, upper side, male.
    Pl. I, fig. 15, upper side, female.
    (a) *eugenia* Wallengren, Pl. I, figs. 16 & 17, upper sides, males.
    Pl. I, fig. 18, upper side, female.
    (b) *ebriola* Poey, Pl. I, fig. 19a, under side, fig. 19b, upper side, male.
    Pl. I, fig. 20, upper side, female.

Papilio delia Cramer, described in 1782, was a homonym, inasmuch as the name *Papilio delia* was preoccupied by Denis and Schiffermueller in 1776. Hübner proposed for *delia* the substitute name *demoditas* in the Verzeichniss Bekannte Schmetterlinge, on p. 96. This work was issued in signatures, and the sixth signature, in which occurred *demoditas* was not issued until 1820. Godart's substitute name of *daira,* issued in 1819, therefore probably takes precedence.

Cepio Godman and Salvin was described as a race of *daira* from Mexico, characterized by being smaller and paler, with whitish fringes instead of reddish. Such specimens do indeed occur, but not nearly so exclusively as they appear to have in Godman and Salvin's material. Fully 70 per cent of the material the author has examined from Mexico has been perfectly typical *daira,* indistinguishable from specimens from the southern United States, the type locality. It therefore seems advisable to place *cepio* in synonymy, inasmuch as the characters cited do not occur constantly enough to validate the use of the name as a race.

Eugenia Wallengren, described from the island of St. Joseph, probably located in the Gulf of California, appears to the writer to be applicable to the form generally known as *rhodia* Felder. The original description is excellent and leaves no room for doubt on this point. The type was evidently a female. *Eugenia* differs from *d. daira* in having the secondaries white in the male and both wings whitish in the female, with a slightly less intense coloring beneath. Transitionals commonly occur between the two forms, especially in the female sex, where their ranges overlap. *Eugenia* ranges from Mexico to Brazil, and *daira* ranges from the southern United States into Mexico. Evidently *eugenia* is to be placed as a race of *daira.* *Persistens* Butler & Druce merely refers to specimens of *eugenia* from Costa Rica. No constant difference can be found between *eugenia* and *persistens,* and the latter is accordingly placed as a synonym.

Ebriola Poey from Cuba is evidently closely related to *eugenia,* differing in a reduction in width and a straightening of the submarginal bar of the primaries above of the males, and in a slight reduction of the black apical patch on the secondaries above in both sexes. Specimens of *eugenia* from Panama are almost indistinguishable from typical specimens of *ebriola* from Cuba. It seems advisable, however, in view of the comparative constancy of *ebriola* throughout the West Indies, to separate it from *eugenia* as another race of *daira*. Typical *ebriola* from Cuba are of a very reddish tinge on the secondaries beneath. Specimens from Jamaica show a rather more yellowish brown, or even a yellowish gray. Specimens from Haiti have a greater suffusion of yellow on the primaries beneath and a slightly larger apical patch on the secondaries above. In all forms there is a rather heavy clouding of fuscous scales and a distinct pattern of broken wavy submarginal lines on the secondaries beneath.

There is considerable of a question in the writer's mind, in which Mr. N. D. Riley of the British Museum concurs, as to whether *daira, jucunda, nigrocincta* and *palmyra* may not all represent merely seasonal and geographical forms of one species. In this case *daira* and its forms would represent a more heavily colored, probably wet season form, and *jucunda* would represent a lightly colored, probably dry season form. There is considerable evidence to back up this theory. For the most part the ranges of the two species coincide. The average of all the specimens examined shows, moreover, that they tend to occur in the same locality at opposite seasons. The male genitalia of all the forms are nearly identical, but are also nearly identical with *elathea*.

However, in view of the evident close relationship of *daira* and *jucunda* it is evident that they have been derived from some common stock, and have not yet differentiated very far. We would, therefore, expect the ranges to be more or less coincident. Regarding the seasonal differences the following exceptions are important: in Mexico there is an overlap of occurrence from October to March of *daira* and *jucunda* f. *sidonia*; in Cuba *palmyra* has been recorded from August to November and *ebriola* in August, December, January and February; in Jamaica *palmyra* has been recorded in November, December and March, and *ebriola* in January; in St. Vincent *palmyra* and *ebriola* both occur in April. These overlaps of seasonal occurrence appear a bit too great to allow of placing *daira* and *jucunda* as seasonal forms of the same species on the basis of present evidence. What is needed badly is accurate life-history work. Anybody doing such should, however, keep strongly in mind the possibility of *daira, jucunda* and *palmyra* being conspecific.

11. *elathea* Cramer, Pl. I, fig. 21, upper side, male.
Pl. I, fig. 22a, under side, female.
Pl. I, fig. 22b, upper side, female.
ab. *venilia* D'Almeida, Pl. I, fig. 23, upper side, male.
f. *flavescens* Chavannes, Pl. I, fig. 25, upper side, male.

Pl. I, fig. 26, under side, male.
f. *mycale* Felder, Pl. I, fig. 24, upper side, male.
f. *tegea* Felder, Pl. I, fig. 28, upper side, male.
f. *medutina* Felder, Pl. I, fig. 27, upper side, male.

Elathea presents the most puzzling situation in the group. In the first place there has always been considerable doubt as to just what form the name applies to. In the second place the species shows an exceedingly great amount of variation, so that it is almost impossible to draw any clear-cut distinction between the forms. Definite variations cannot be assigned to definite localities—either there is too great an amount of individual variation or else the same variation proves to be repeated in a number of widely separated localities. A very large number of rather close geographic races might be split off, but this would be far too cumbersome if carried to completion. The distinctions drawn in the key are, therefore, to be regarded as purely arbitrary, and as merely affording a convenient and probably temporary means of classification. Intergrades occur so frequently between even the few forms recognized that numbers of specimens will be found that cannot be definitely placed. What *elathea* needs, and needs badly, is not more names or study of adult specimens but an exhaustive study of the early stages in the hope of finding some clue to this mass of variation.

All the forms placed under *elathea* possess one character in common—the presence of a black submarginal bar on the upper side of the primaries of the males, as distinguished from the other species where the bar is gray. There is so much individual variation that splitting into more than one species would only introduce fresh complications. The Antillean form shows the greatest homogeneity, all specimens possessing a well-defined pattern of fuscous scales on the under side of the secondaries. The ground color of the secondaries beneath varies from red-brown to brownish yellow. This agrees well enough with Cramer's plate of *elathea*. Inasmuch as Cramer's data regarding the type locality of *elathea* are not to be trusted it seems wisest to apply the name to the Antillean form. The variations among Antillean specimens, though in some cases well marked, do not warrant the application of any more names. *Midea* Menetries, described from Santo Domingo, is therefore placed as a synonym.

Occasional males occur as aberrational forms, lacking the black bar on the primaries, over the entire range of the species. To this the name *venilia* has been applied by D'Almeida. The same aberration occurs in others of the barred species, but does not seem worth any further naming. It is worthy of note that those males which lack the bar almost invariably show a decided increase in the intensity of coloring of the wings beneath.

The remainder of the forms, occurring all over Central America and northern and central South America, have been merely arbitrarily divided up for convenience in classification. In the future it may be possible for someone, having more data available, to do better.

One form, however, deserves special mention. *Mycale* Felder was described as having the submarginal bar of the primaries continuous with the marginal border. The character is distinct enough so that *mycale* specimens are for the most part unmistakable. Occasional specimens occur, however, in which the bar only partly reaches the border. *Mycale* cannot at present be said to occur in any definite localities or at any definite season. It is, however, the dominant form in Surinam during April. Specimens occur frequently from various parts of Matto Grosso, and from Minas Geraes, Manaos, Pará, Rio and Teffé in Brazil, from Bogotá, Choachi and Villavicencio in Colombia, and from various localities in Argentina. Type locality—Bahia, Brazil.

Tegea Felder shows some slight signs of being a localized race from Colombia and Venezuela, but *medutina* specimens from the same localities show a tendency to intergrade with *tegea*. Type locality—Bogotá, Colombia.

Specimens here placed under *medutina* come from a wide range of localities. The author has examined specimens from La Cumbre, Bogotá, Villavicencio, Choachi and Las Vegas in Colombia, from El Campamento, Chanchamayo dist., Lima, Hacienda San Juan and other points in Peru, from Paramaribo, Surinam, and Province del Sara, Bolivia. Type locality—Venezuela. There is much intergrading with *flavescens*, and many specimens cannot be definitely determined.

Specimens of *flavescens* with the secondaries beneath more heavily marked with reddish brown than usual intergrade with *elathea*, and specimens with less reddish brown or ochraceous than usual intergrade with *medutina*. Specimens of *flavescens* have been examined from Castra Punta, Rio de Janeiro, Pará, Manaos, and Matto Grosso in Brazil, from Choachi and Villavicencio in Colombia, from Riobamba in Ecuador, from El Campamento and Lima in Peru, from Caracas, Venezuela, from Paso de los Libros, Argentina, and from Uruguay. Type locality—Caracas, Venezuela.

12. *agave* Cramer, Pl. II, fig. 29, upper side, male.
(a) *sinoides* Capronnier, Pl. II, fig. 30, upper side, male.

Jodutta Hübner was applied as a substitute name, because of the supposed homonymy of *Papilio agave* with *Papilio agavus* Denis & Schiffermüller. Specimens from southern Brazil agree in lacking the marginal border on the secondaries above, constituting a valid race which has been named *sinoides* by Capronnier.

13. *phiale* Cramer, Pl. II, fig. 31, upper side, male.
(a) *columbia* Felder (?).

Phiale appears to show comparatively little variation. Specimens from Colombia often have the black border of the secondaries reduced or missing, and to this form the name *columbia* Felder is applied as a race, though somewhat doubtfully. *Singularis* D'Almeida from southern Brazil (vicinity of Rio) was described from a female with the border of the primary reduced, that of the secondary lacking, and a yellowish suffusion. It cannot be held as a valid form or race on the scanty evidence presented, as likewise *paula* Röber, which also applies to southern Brazil specimens.

14. *pyro* Godart, Pl. II, fig. 39, upper side, male.
f. *hyona* Menetries, Pl. II, fig. 40, upper side, male.

In the series of *pyro* and *hyona* in the American Museum of Natural History all of the *pyro* are from sea level and most of the *hyona* are from 1,600 ft. altitude. This looks suspiciously as if *hyona* were an altitude form, but the evidence is not complete enough to so place it here. *Pyro* is one of the very few species of *Eurema* which appears to have no synonyms—something to be wondered at.

15. *messalina* Fabricius, Pl. II, fig. 41, upper side, male.
Pl. II, fig. 42a, under side, female.
Pl. II, fig. 42b, upper side, female.

In placing *bulaea* Boisduval as a synonym of *messalina* the writer follows Poey and Herrich Schaffer. The description of *bulaea* might well apply to any of half a dozen species of *Eurema*. The type locality given, Senegal, is evidently incorrect.

Blakei Maynard applies to a lightly marked specimen of this species from the Bahamas. Whether this constitutes a valid race is a bit of a question. The writer thinks that it does not, for individuals of *messalina* from Cuba, the type locality, are very often just as lightly marked as any from the Bahamas, and sometimes more so than the type, which he has examined.

16. *portoricensis* DeWitz, Pl. II, fig. 43, upper side, male.

Portoricensis is often confused with lightly marked specimens of *dina* Poey. Genitalically it is identical with *pyro* and *messalina* and distinct from anything else. So far as I know the species occurs only in Porto Rico. *Tenera* Avinoff applies to a perfectly normal individual.

17. *nicippe* Cramer, Pl. II, fig. 36a, under side, male.
Pl. II, fig. 36b, upper side, male.
Pl. II, fig. 37, upper side, female.
f. ♀ *flava* Strecker, Pl. II, fig. 38, upper side.

That *nicippe* is a very distinct species is evidenced by the fact that it shares with very few others the distinction of having no synonyms. *Flava* is a dimorphic yellow female form.

18. *adamsi* Lathy, Pl. II, fig. 47a, under side, male.
Pl. II, fig. 47b, upper side, male.
Pl. IV, fig. 100, upper side, female.

Adamsi is an exceedingly rare species in collections. Mr. Lathy tells me that this is due to its environment, which is limited to the mountainous regions of Jamaica. Here it sometimes occurs commonly, but its fast flight combined with the roughness of the terrain make it a very difficult insect to catch. Structurally its affinities are with the seven following species which have the secondaries tailed or angulate. Genitalically it is almost identical with *boisduvaliana*. It differs from these species, however, in not having R_s and M_1 of the secondary stalked. There is considerable variation in the width of the marginal border, which appears to be seasonal.

19. *ecuadora* Hewitson, Pl. II, fig. 48, upper side, male.

Ecuadora is a model species in that it is very distinct and has no variations. Its only fault is that it is quite rare. The female is unknown to me.

20. *gratiosa* Doubleday & Hewitson, Pl. II, fig. 49, upper side, male.
Pl. II, fig. 50, upper side, female.

Gratiosa appears to remain quite constant throughout its entire range, which includes Colombia, northern Brazil, Venezuela and Panama. Godman and Salvin mention a specimen from Panama possessing very narrow black margins, which is possibly referable to *arbela graduata*. *Theona* Felder, first described as the female of *theodes*, evidently refers to a female of *gratiosa*.

21. *boisduvaliana* Felder, Pl. II, fig. 51, upper side, male.
Pl. II, fig. 52, upper side, female.

Reakirt confused this species with *gratiosa* Doubleday & Hewitson. *Ingrata* Felder applies to a *boisduvaliana* with the red markings beneath reduced, a variation which is certainly not worth a name.

22. *arbela* Hübner, Pl. II, fig. 53, upper side, male.
(a) *graduata* Butler, Pl. II, fig. 54, upper side, male.
(b) **elsia** new subspecies, Pl. II, fig. 55, upper side, male.

Hübner's plate of *arbela* is unmistakable. *Arbela* may, however, be sometimes confused with forms of *salome* Felder, from which it is fortunately most distinct genitalically.

The author has examined specimens of *a. arbela* from the following localities: Brazil—Novo Friburgo, Rio de Janeiro; Peru—Yurimaguas, June, Col. Perené, June 8, El Campamento, June 21; Argentine—Tucuman, February; Bolivia—Prov. del Sara. Type locality, "Java and Brazil."

Graduata appears to be a lower Amazon race. The author has specimens from Teffé, Brazil, taken between December 6 and January 7, and from Obidos, Brazil, August 22–29.

Elsia may not be so distinct a race. The type is from 28 km. east of Bogotá, Colombia. The paratype is from the Hoffman Collection, American Museum of Natural History, labeled "Chapada, February." The data on specimens in the Hoffman Collection are untrustworthy. The "Chapada" in southern Brazil is probably the one meant.

Eurema arbela **elsia**, new subspecies, Pl. II, fig. 55, upper side, holotype male.

Differs from *a. arbela* and *a. graduata* as follows:

1. The ground color of the upper side of both wings is white. In *a. arbela* both wings above are yellow, and in *a. graduata* the primaries above are yellow and the secondaries white.

2. The apical orange suffusion on the secondaries above is more reduced than in *a. arbela* or *a. gratiosa*.

3. The red markings on the secondaries beneath are both lighter in color and more reduced in extent than in *a. arbela*.

The wing venation and male genitalia of *a. elsia* are identical with those of *a. arbela* and *a. graduata*.

Holotype male, from 28 km. east of Bogotá, Colombia, in author's collection.

Paratype male, "Chapada, February," in collection of American Museum of Natural History, New York City, N. Y.

23. *xanthochlora* Kollar, Pl. II, fig. 56, upper side, male.
(a) *pomponia* Hopffer, Pl. II, fig. 57, upper side, male.
Pl. III, fig. 58a, under side, female.
Pl. III, fig. 58b, upper side, female.
f. ♀ **marjoria** new form.

Over the greater part of its range, which is large—from Mexico to Peru—*xanthochlora* shows little appreciable variation. Specimens from Peru, however, show marked differences, as noted in the key, and clearly constitute a valid race to which the name *pomponia* Hoppfer is applicable. *Sybaris* Hopffer refers merely to a yellow female of *pomponia*. *Constantia* Felder and *paulina* Bates refer to minor variations of *x. xanthochlora* which are not worth a name.

As in many other species of *Eurema* a white female form occurs. This can rather easily be confused with females of *gratiosa* which are normally white. The author, therefore, applies to it a name as follows:

Eurema xanthochlora pomponia f. ♀ **marjoria** new form.

Distinguished from normal females of *xanthochlora pomponia* by the fact that the ground color of the wings, both above and below, is white instead of yellow, and that the red markings on the underside of both wings are lighter in color and more limited in extent.

Holotype female, Pueblo Pardo, Col. Perene, Peru, June 12, 1920, in collection Cornell University.

Paratype female, El Campamento, Col. Perene, Peru, June 11, 1920, in collection Cornell University.

It seems to the author that color forms of races may also be considered as applicable to all races of the same species. This is, however, a matter that will bear considerable discussion. Such a proceeding would certainly result in cutting down an inordinate number of names.

24. *mexicana* Boisduval, Pl. III, fig. 59, upper side, male.
Pl. III, fig. 60, upper side, female.
(ab) **recta,** new aberration, Pl. III, fig. 61, upper side, holotype male.
(ab) *biedermanni* Ehrmann.
(a) *bogotana* Felder, Pl. III, fig. 62, upper side, male.
Pl. III, fig. 63a, under side, female.
Pl. III, fig. 63b, upper side, female.

Typical *mexicana* has the emargination of the black border of the primary rather narrow and decidedly hooked downward, as is

shown in the figure. With regard to this emargination two lines of variation are apparent. In one, named *biedermanni* by Ehrmann, this white emargination is being filled in with black. For Holland's figure of the type see Ann. Carnegie Mus., Vol. XVII, no. 2, 1927, Pl. XXV, fig. 6. In the other line of variation the emargination is broadened out and square, lacking the hook downward at the tip. This hook downward is so characteristic of *mexicana* that to avoid confusion it seems best to the author to name this aberration:
Eurema mexicana ab. **recta** new aberration.

Length of primary of holotype, measured from base of costa to apex, 20 mm.

Differs from *mexicana* in that the white emargination of the black border of the primary above is square-ended and extends from M_3 to Cu_2, whereas in typical *mexicana* this emargination is much narrower and hooked downward at the tip. The entire ground color of *recta* is a more yellowish white than in typical *mexicana* and the costal orange on the secondary above is more suffused downward. The black marginal border of the secondary is more reduced than in typical *mexicana*.

Holotype male, Texas, purchased from O. Fulda, in collection American Museum of Natural History, New York City, N. Y.

The general suffused coloration and small size of this specimen are more or less characteristic of northern *mexicana* specimens. The present specimen also bears a curious but undefinable resemblance to a female *mexicana*. The widening out of the emargination in the border of the primary is characteristic of several other species of *Eurema*.

From Costa Rica to Colombia *mexicana* is represented by the race *bogotana* Felder. Males of this race are characterized by the absence of the orange on the secondaries above. Females of *bogotana* have the marginal border of the primaries far more reduced than do females of *m. mexicana*. They are very easily confused with females of *salome* Felder from which they may be separated by their whitish ground color and heavy red markings on the secondaries beneath. *M. mexicana* has been recorded from Panama and Honduras.

Henrici Maria applies to an aberration of *m. bogotana* from Colombia which corresponds to *mexicana* ab. *biedermanni* Ehrmann. The writer does not believe in holding different names for the corresponding aberrations of subspecies, and so has placed *henrici* as a synonym.

25. *salome* Felder Pl. III, fig. 64, upper side, male.
Pl. III, fig. 67a, under side, female.
Pl. III, fig. 67b, upper side, female.
f. *limoneus* Felder Pl. III, fig. 65, upper side, male.
f. *fabiola* Felder Pl. III, fig. 66, upper side, male.

Salome is a rather variable species, occurring from Mexico to Ecuador, and possibly still further south. Three forms are recognizable and sufficiently distinct to be worth a name. These do not, however, appear to constitute valid races but merely forms (possibly seasonal), often occurring in the same localities and intergrading freely. Moreover, the females of all three forms are indistinguishable from each other. The author has examined specimens from the following localities:

salome. Colombia (Villavicencio, Bogota, Choachi); Ecuador (Huigra).

limoneus. Mexico (general); Costa Rica (Cartago); Colombia (Choachi, Bogotá); Ecuador; Venezuela (Mucuchachi).

fabiola. Colombia (Bogotá); Venezuela (Carácas); Peru (general).

Specimens of *limoneus* from Central America show a slightly heavier suffusion of orange on the secondaries above, but are otherwise indistinguishable from specimens from further south. Inasmuch as *limoneus* ranges so much further north than the other forms it might be considered as a northern race. The writer hesitates to do this, however, feeling that the evidence is insufficient.

The females remain extremely constant throughout the entire range of the species. In pattern they show a marked relationship to the females of *mexicana bogotana*, from which they can be distinguished by the yellow ground color and the ochraceous reticulations and suffusion on the under side of the secondaries. *Jamapa* Reakirt refers to a female *limoneus* from Vera Cruz, Mexico, in no way differing from typical specimens.

26. *amelia* Poey, Pl. II, fig. 33, upper side, male.

Amelia appears to be a rather rare species, and one little known. It stands apart from all other species of *Eurema* in having R_2 of the primary shortly stalked on $R_3 + R_{4+5}$. Genitalically it is also distinct from all other species. It seems advisable to give a description of the wings beneath:

Primaries beneath white, shaded with yellow and fuscous scales along the costa and to the apex. A fuscous line at upper end of cell.

Secondaries beneath yellowish, thickly powdered with fuscous scales. A broken wavy submarginal line of fuscous dots. Two spots at end of cell, the upper one the larger. Range: Cuba.

27. *proterpia* Fabricius, Pl. III, fig. 68, upper side, male.
Pl. III, fig. 69, upper side, female.
(a) *watsonia* Klots, Pl. III, fig. 70, upper side, paratype male.
Pl. III, fig. 71, upper side, allotype female.

Proterpia watsonia was described by the present writer as a race from Ecuador on the basis of a series of male specimens. The race is characterized by its more intense orange coloring and by the increase in extent of both the black scaling along the veins and of the marginal fuscous shading. Recently the writer acquired a female of this race, which shows similar characteristics. Accordingly he hereby wishes to fix this specimen as the allotype and does so as follows:

Eurema proterpia watsonia Klots, allotype female, Ecuador.
Pl. III, fig. 71, upper side.

Differs from *p. proterpia* females in the following characteristics:

1. Ground color of wings above slightly deeper orange.
2. All veins above scaled with fuscous except discocellulars of secondaries.
3. Marginal border of primaries heavier, extending broadly to inner margin.
4. Marginal border of secondaries heavier, extending broadly to tip of Cu_2.
5. Both primaries and secondaries above dusted with fuscous scales over entire surface, more thickly near bases and marginal borders.

Length of primary from base of costa to apex, 22.5 mm. Allotype deposited in collection American Museum of Natural History, New York City, N. Y.

Since the publication of the original description of *proterpia watsonia* the author has deposited a male paratype in the collection of each of the following: British Museum, London, Eng.; Hill Museum, Witley Surrey, Eng.; U. S. Nat'l. Museum, Washington, D. C.

28. *gundlachia* Poey, Pl. III, fig. 72, upper side, male.
Pl. III, fig. 73, upper side, female.

Specimens of *gundlachia* are sometimes very hard to distinguish from *proterpia*. In general the tails of the secondaries are a bit more pronounced in *gundlachia* and the secondaries beneath are more apt to be more deeply colored with brown.

Maria has applied the name *alba* to a white female form of *gundlachia,* a name already used in *Eurema* (*Eurema lisa* f. ♀ *alba* Strecker). There is, however, no statement in the International Code of Zoological Nomenclature to the effect that a varietal name shall not be repeated within a genus. The writer has, therefore, accepted this name as valid. Indeed it would be an excellent idea, in his opinion, if the same designation were used for all corresponding varietal forms in the same genus. Such a proceeding would do away with one danger of our system of nomenclature becoming too cumbersome. The writer is well aware that he himself has given different and, he hopes not preoccupied names to two white female forms in the present paper. That, however, is the fault of the Code which has left this point indefinite. The writer knows perfectly well that if he had not named these forms, merely calling attention to their existence, someone else would have done so.

29. *lisa* Boisduval & Leconte, Pl. III, fig. 74, upper side, male.
Pl. III, fig. 75, upper side, female.
f. *clappi* Maynard, Pl. III, fig. 76, upper side, male.
f. ♀ *alba* Strecker, Pl. III, fig. 77, upper side, female.
(a) *euterpe* Menetries, Pl. III, fig. 78, upper side, male.

As pointed out by Barnes and McDunnough (Contrib. Nat. Hist. Lep. N. A., Vol. IV, No. 2, p. 67) *lisa* Boisduval & Leconte takes precedence over *euterpe* Menetries. *Lisa* refers to the North American form of the species. *Euterpe* then applies to the Central American and West Indian race, which is of somewhat doubtful value. *Sulphurina* Poey refers to a *euterpe* from Cuba which appears to show no differences sufficient to validate the name. *Clappi* Maynard refers to a form with the marginal border of the secondaries reduced to an apical patch and a narrow straight line. It is worthy of retention as a form. *Alba* Strecker is a dimorphic white female form. *Centralis* Herrich Schaffer, described in his Schmetterlinge der Insel Cuba undoubtedly refers to a white female of *lisa euterpe.* A specimen in the British Museum from the Kaden Collection is so labeled.

Lisa need in no forms be confused with any other New World species. It has been confused with *smilax* Donovan (often attributed to Godart), a rather similar yet distinct Old World species. It has also been confused with *thymetus* Fabricius, a form discussed by the writer under species 4, *pseudomorpha.*

30. *dina* Poey, Pl. III, fig. 79, upper side, male.
f. ♀ *citrina* Poey, Pl. III, fig. 80, upper side, female.
f. *memulus* Butler, Pl. IV, fig. 83, upper side, yellow male.
Pl. IV, fig. 84, upper side, female.
Pl. IV, fig. 85, upper side, orange male.
(a) *westwoodi* Boisduval, Pl. IV, figs. 81–82, upper side, males.
(b) *parvumbra* Kaye, Pl. IV, fig. 86, upper side, male.
(c) *leuce* Boisduval, Pl. IV, fig. 87, upper side, male.
Pl. IV, fig. 88, upper side, female.

This species presents a number of complications. *Dina dina* is from the Greater Antilles. F. ♀ *citrina* Poey, described from Cuba and also found occurring on others of the Greater Antilles, is probably a valid form, characterized by smaller size, and a limiting of the orange suffusion on the secondaries above to the apical and marginal regions. *Westwoodi* Boisduval as a mainland Central American race is distinct enough to be valid, characterized by its larger size and greater suffusion of orange on the secondaries. Specimens of *westwoodi* occur (fig. 82) with the black marginal border of the primaries greatly reduced. The variation is not good enough to be worth a name, all the more as a valid race of *dina*, i.e., *parvumbra* Kaye from Jamaica is characterized by the same thing, combined with smaller size and more yellow coloring. In Haiti orange forms of *dina* appear to be dominant, but yellow specimens occasionally occur, flying with the orange ones. This yellow form is *memulus* Butler, which is here placed as a color form.

Of rather wide distribution in South America and extending up into Panama is another race of *dina* to which the name *leuce* Boisduval applies. *Diodina* Butler, *flavilla* Bates, *circumcincta* Bates and *hahneli* Staudinger are all synonyms of *leuce*, representing at most merely minor variants. There appears to be more or less intergrading between *leuce* and *nise* Cramer. *Athalia* Felder evidently refers to specimens somewhere in this intergrade series. In the Biologia Centrali-Americana is figured a specimen which had been compared with the type of *athalia*. This is referrable to *leuce*, so *athalia* is so placed, rather than as a form or synonym of *nise*, which should appear more likely from the original description. It is probable that *dina* was derived from some *nise* form and that *athalia* represents more or less of a transitional stage.

31. *chamberlaini* Butler

The writer is puzzled by *chamberlaini*. Described from the Bahamas, it is one of three things: (1) A valid and extremely rare species. (2) An Oriental species allied to *Eurema laeta*, described on the basis of incorrect data. (3) A synonym or race of *E. lisa*. The second is very unlikely, while either of the others is very possibly correct. It is here placed tentatively as a species. The question can be settled by some one with access to the type, if this is in existence. There is also some possibility that it represents a form of *E. nise* but this is very doubtful as *nise* is not known to occur anywhere near the Bahamas, while *lisa* undoubtedly does.

32. *nise* Cramer, Pl. IV, fig. 89, upper side, male.
Pl. IV, fig. 90a, under side, male.
Pl. IV, fig. 90b, upper side, male.
(a) *stygma* Boisduval, Pl. IV, fig. 91, upper side, male.
Pl. IV, fig. 92a, under side, female.
(b) *perimede* Prittwitz, Pl. IV, fig. 92b, upper side, female.
Pl. IV, fig. 93a, under side, male.
Pl. IV, fig. 93b, upper side, male.
Pl. IV, fig. 94, upper side, female.

There has been a great deal of confusion as to the correct application of the name *nise* Cramer. Cramer's plates show the primaries and secondaries above of the same color. Boisduval states that this is due to a mistake in the coloring and that *nise* really refers to a specimen in which the primaries are of a deeper shade of yellow than the secondaries. Möschler takes exception to this, claiming that Cramer meant his plate to have the wings concolorous above. He then proposes the name of *diosa* for the form with the primaries of a deeper yellow than the secondaries, which Boisduval had called *nise*. In confirmation of Möschler's views it must be noted that Cramer compares his *nise* to *E. hecabe* L., an Old World species which has the wings above concolorous. It therefore seems that Möschler was correct, and that the name *nise* Cramer should be applied to the species with the wings above concolorous yellow, having two discocellular dots on the secondaries beneath and none on the primaries.

Specimens of this species from Central America, however, invariably possess a discocellular dot on the primaries beneath. To this form the name *perimede* Prittwitz applies, as a race of *nise*. Specimens, especially females, show considerable variation with regard to the width and extent of the marginal border above and the intensity of the wavy markings on the secondaries beneath. A number of names have been applied to such variants. Study of a considerable series of specimens from all parts of Central America shows that the validation of any of these names as races is impossible; and the differences are certainly not great enough to warrant the application of varietal names. These names have, therefore, been placed as synonyms of *nise perimede.*

The typical *nise* form, occurring over most of mainland South America, shows as does *nise perimede* much variation. Again this has resulted in the loose application of names to a number of forms which are certainly not geographical races and which do not show sufficient difference or stability to be worth consideration as color forms. There are no data to show that any of the forms are seasonal. They have, therefore, been placed as synonyms.

Two forms only appear worth validation. *Stygma* Boisduval from Peru probably constitutes a good geographic race, characterized by the presence of considerable red on the secondaries beneath (dry season form ?). *Nise nise* females from all parts of South America show this character, but the author has seen no males with distinct red markings on the secondaries beneath from anywhere else but Peru, and has seen a considerable number of such specimens from there. Ab. *alcides* D'Almeida appears, from the original description, to be an exceedingly distinct variant and one well worth a name. The writer wishes he could say as much for the other *nise* forms described by the same author which, however, are merely minor variants and are placed in synonymy.

Cordobensis Köhler, from the Argentine, might possibly be a valid race. The available data are, however, too meagre. *Tenella* Boisduval was applied to a form with a wide black border on the secondaries. The variation is too common. Cramer's plate of *nise* shows no border on the secondaries, but I suspect that the specimen was a female, which sex commonly lacks the border. *Tenella* can, therefore, merely be taken as applying to the male of the species and is, therefore, a synonym. *Floscula* Weeks, from Bolivia might be a valid race, but the data are too meagre. *Thymetus* Fabricius, which has been applied to various *nise* forms, is not properly a *Eurema* at all.

33. *venusta* Boisduval, Pl. IV, figs. 95–96, upper sides, males.
Pl. IV, figs. 97–98, upper sides, females.
f. *limbia* Felder, Pl. IV, fig. 99, upper side, male.

Möschler's substitution in 1882 of *diosa* as applicable to the species with the primaries above of a deeper yellow than the secondaries, called *nise* Cramer by Boisduval, is not valid, as Boisduval had applied the name *venusta* to a specimen of this species, in

1836. Of this I am assured by Mr. N. D. Riley of the British Museum who had examined the type, a ♂ from Martinique. Felder applied the name *aequatorialis* to this species in 1881.

Venusta applies to specimens in which the secondaries are plainly yellow, though lighter in color than the primaries. *Limbia* Felder applies to specimens lacking any yellow on the secondaries, which are white and in strong contrast to the primaries. There is much intergrading between the two forms. Neither form can be assigned to any definite locality, making the allocation of races out of the question. There is considerable variation with regard to the presence or absence of the black border of the primaries above, and also as regards the intensity of the wavy markings on the secondaries beneath. None of the variants here have been named, nor do any of them appear worth a name. Specimens from Colombia have the wavy markings beneath in general more prominent than specimens from any other locality. Specimens from St. Lucia, St. Thomas and Grenada are apt to have the border of the secondary greatly reduced, and are often smaller and more washed-out looking.

deflorata Kollar

From the description quoted by Röber in Seitz, Macrolep. Vol. V, this would be a synonym of *albula*. The writer has been unable to find the original description, as the reference given for it by Röber is incorrect, and it does not appear to be mentioned anywhere else.

arabella Hübner

The reference cited by Kirby, Cat. Diurn. Lep., p. 445 is incorrect, and the writer can find no other reference to this form.

Bibliographical List of New World Eurema Names

References are to the original descriptions. Numbers in parentheses are those of the species in the present article to which the name applies. Names in parentheses are the genus in which the author originally placed the species.

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Of course there will prove to be mistakes, omissions, and errors of judgment. The author can only hope that such will be viewed with toleration, and that persons using the paper may tell him their opinions.

The list of names is, as nearly as possible, complete through the 1926 volume of the Zoological Record, and the literature to the end of 1927.

EXPLANATION OF PLATES

A few words of warning appear advisable to users of these plates. In the first place, while the plates are accurate as far as showing the markings of the specimens, they are not to be taken too seriously as regards the color. Accordingly a short color description of each specimen figured has been appended below. Secondly, markings on the under side of the wings show through in some cases in figures of the upper side, and *vice versa.*

PLATE I. ALL FIGURES × 1

Fig. 1. *E. lucina* Poey ♂, Cuba, in coll. author. Wings above white, borders brownish-black, submarginal bar and shading on costa diffuse gray. Wings beneath with chrome-yellow and fuscous clouded markings.

Fig. 2. *E. lucina* f. *fornsi* Poey ♂, Pinar del Rio Cuba, Sept. 12–23, 1913, in coll. author. Coloring as in *lucina.*

Fig. 3. *E. p. priddyi* Lathy ♀, Port-au-Prince, Haiti, Mar. 5–11, 1922, in coll. Amer. Mus. Nat. Hist. Wings above yellow, borders brownish-black. Primaries beneath yellow with fuscous cloudings, secondaries lighter yellow with fuscous cloudings and diffuse markings.

Fig. 4. *E. priddyi forbesi* Klots paratype ♂, 12½ km. South of Pinar del Rio, Cuba, Sept. 12–23, in coll. author. Wings above white, borders and costal shading brownish-black. Primaries beneath white, yellowish and fuscous dusted at base and apex, discocellular dark brownish. Secondaries beneath yellowish with fuscous clouding and markings, diffuse.

Fig. 5. *E. priddyi forbesi* Klots holotype male, Isle of Pines, Cuba, in coll. Amer. Mus. Nat. Hist., coloring as in Fig. 4.

Fig. 6. *E. jucunda* Boisduval & Leconte ♂, Lakeland, Fla., U. S. A., May 8, 1912, in coll. author. Wings above yellow, borders and bar brownish-black, inner margin of primaries beneath bar orange. Primaries beneath yellow, dusted with fuscous, pearly on inner margin. Secondaries beneath whitish, dusted with fuscous.

Fig. 7. *E. jucunda* ♀, Gainesville, Fla., U. S. A., Sept. 26–Oct. 2, 1914, in coll. author. Coloring as in Fig. 6, slightly lighter throughout, inner margin of primaries beneath whitish, not pearly.

Fig. 8. *E. jucunda* f. ♀ *pallidula* Klots holotype female, Barrios, Guatemala, Dec. 14, 1912, in coll. Amer. Mus. Nat. Hist. Wings above white, borders and shadings brown. Wings beneath white, primaries faintly shaded with yellow basally and apically, some faint fuscous dusting on both wings.

Fig. 9. *E. jucunda* f. *sidonia* Felder ♂, Cuernavaca, Mexico, in coll. author. Coloring as in *j.* f. *jucunda* ♂, less yellow on primaries beneath.

Fig. 10. *E. nigrocincta* Dognin. Copied from plate of author in "Notes sur la Faune Lepidopteres de Loja et environs (Equateur)," P. Dognin, Paris, 1887, Pl. III, Fig. 6. Coloring as in *sidonia.*

Fig. 11. *E. palmyra palmyra* Poey ♂, Havana, Cuba, Aug. 10–22, 1925, in coll. author. Wings above: primaries yellow, secondaries white, borders blackish-brown. Wings beneath pearly white, very lightly dusted with fuscous scales.

Fig. 12. *E. palmyra lydia* Felder ♂, Onealio, Mexico, Nov. 10, 1912, in coll. author. Wings above colored as in *p. palmyra.* Secondaries beneath more heavily dusted with fuscous scales.

Fig. 13. *E. palmyra lydia* Felder ♂, Cartago, Costa Rica, in coll. author. Coloring as in Fig. 12.

Fig. 14. *E. daira daira* Godart ♂, Crestview, Fla., U. S. A., Oct. 16, 1914, in coll. author. Wings above yellow, borders blackish-brown, bar gray, hairy, inner margin below bar orange. Primaries beneath yellow, inner margin pearly white to gray, costa, apex and outer margin red-brown dusted with fuscous scales. Secondaries beneath red-brown, dusted with fuscous scales.

Fig. 15. *E. daira daira* Godart ♀, Texas, U. S. A., in coll. author. Colors above as in male. Inner margin of primaries beneath more narrowly whitish. Secondaries beneath more intensely colored than in male.

Fig. 16. *E. daira eugenia* Wallengren ♂, Jalapa, Mexico, in coll. author. Primaries above yellow, borders blackish-brown, bar brownish-gray, inner margin below bar orange. Secondaries above white, border blackish-brown. Primaries beneath light yellow, pearly white and gray on inner margin, red-brown dusted with fuscous on costa, apex and outer margins. Secondaries

beneath light reddish-brown, dusted with fuscous, a diffuse submarginal broken wavy band.

Fig. 17. *E. daira eugenia* Wallengren ♂, Taruma, Ecuador, in coll. author. Coloring as in Fig. 16, bar grayer, coloring beneath more intense.

Fig. 18. *E. daira eugenia* Wallengren ♀, Cartago, Costa Rica, in coll. author. Wings above white, tinted with yellow. Wings beneath as in Fig. 16 but with inner margin of primaries only narrowly whitish.

Fig. 19. *E. daira ebriola* Poey ♂, San Carlos Estate, Guantanamo, Cuba, Dec. 22, 1918, in coll. Amer. Mus. Nat. Hist. Coloring above as in Fig. 16, but with bar lighter gray. The bar is narrower and straighter than in *d. eugenia.* In the figure it is confused with the orange margin below it. Coloring beneath as in Fig. 16, the secondaries a more pinkish-brown.

Fig. 20. *E. daira ebriola* Poey ♀, Mandeville, Manchester, Jamaica, B. W. I., Dec. 14, 1919, in coll. Amer. Mus. Nat. Hist. Wings above white (in some specimens tinted with yellow), borders blackish-brown. Primaries beneath suffused with yellowish (in some specimens strongly yellow), yellowish-brown to reddish-brown on costa, apex and outer margin. Inner margin pearly white. Secondaries beneath yellowish-brown to reddish-brown, with fuscous and darker brown dusting and markings.

Fig. 21. *E. elathea* Cramer ♂, Montego Bay, Jamaica, Mar. 2, 1911, in coll. Amer. Mus. Nat. Hist. Primaries above yellow, fuscous dusting along costa, blackish-brown border, bar black, not hairy, inner margin below it orange. Secondaries above white, border blackish-brown. Primaries beneath white, subcostally tinted with yellow, costa, apex and outer margin light brownish dusted with fuscous, inner margin pearly. Secondaries beneath light brownish, dusted and marked with fuscous and darker brown.

Fig. 22. *E. elathea* Cramer ♀, Jamaica, B. W. I., in coll. author. Wings above white, tinted with yellowish, borders blackish-brown. Wings beneath as in male, coloring more intense, inner margin of primaries not pearly.

Fig. 23. *E. elathea* ab. *venilia* D'Almeida ♂, Trinidad, B. W. I., Mar. 31, 1927, in coll. author. Coloring above as in

elathea male, with submarginal bar of primaries lacking. Coloring beneath as in *elathea* male, Fig. 21, but deeper throughout.

Fig. 24. *E. elathea* f. *mycale* Felder ♂, Zanderij I., Boven, Para dist., Surinam, Apr. 27, 1927, in coll. Cornell U. Coloring above as in *elathea* male, Fig. 21. Primaries beneath white, subcostally and subapically tinted with yellow, very lightly dusted with fuscous, inner margin pearly. Secondaries beneath white (in some specimens yellowish), lightly dusted with fuscous.

Fig. 25. *E. elathea* f. *flavescens* Chavannes ♂, Pará, Brazil, Oct. 3, 1919, in coll. author. Coloring above as in *elathea* male, Fig. 21. Primaries beneath white, strongly tinted subcostally and subapically with orange yellow; costa, apex and outer margin light ochreous yellow faintly dusted with fuscous; inner margin pearly. Secondaries beneath white; costa and outer margin light ochreous yellow, faintly dusted with fuscous scales.

Fig. 26. *E. elathea* f. *flavescens* Chavannes ♂, under side, El Campamento, Peru, June 4–7, 1920, in coll. Cornell U. Wings beneath as in Fig. 25, but the shading and coloring are everywhere more intense and the fuscous dusting is heavier.

Fig. 27. *E. elathea* f. *medutina* Felder ♂, Urucum, Corumbá, Matto Grosso, Brazil, Dec. 27, 1919, in coll. Cornell U. Coloring above as in *elathea* male, Fig. 21. Primaries beneath white, with a narrow basal subcostal and an apical yellow tinting, costa and apex dusted with gray scales, inner margin pearly. Secondaries beneath dusted with gray or fuscous scales which combine to form narrow, broken, wavy, submarginal band.

Fig. 28. *E. elathea* f. *tegea* Felder ♂, Aguadita, Colombia, June, 1915, in coll. Cornell U. Coloring above as in *elathea* male, Fig. 21. Primaries beneath white, broadly tinted with yellow subcostally and subapically, lightly dusted with fuscous scales along costa and apex, inner margin pearly. Secondaries beneath white, faintly tinted with yellow, slightly deeper at outer margin, sparsely dusted with fuscous scales, with no pronounced markings.

Plate II. All figures × 2/3

Fig. 29. *E. agave agave* Cramer ♂, Iquitos, Brazil, May 11, 1920, in coll. author. Wings above white, borders blackish-brown, costal shading gray. Primaries beneath white, shaded with yellow and sparsely dusted with fuscous along costa, apex and outer margin. Secondaries beneath white, lightly tinted with yellow, more heavily at the margins and with fuscous dusting and diffuse markings.

Fig. 30. *E. agave sinoïdes* Capronnier ♂, Santos, Brazil, May 20, 1919, in coll. Amer. Mus. Nat. Hist. Coloring as in *a. agave,* with yellow tinting and shading of wings beneath heavier.

Fig. 31. *E. phiale phiale* Cramer ♂, Aguadita, Colombia, June 14, in coll. Cornell U. Wings above white, marginal borders blackish-brown, submarginal border of secondaries chrome yellow. Primaries beneath white, base of costa and apex yellow (in some specimens ochraceous yellow). Secondaries whitish suffused with light yellow (in some specimens ochraceous yellow), with darker dustings and suffused markings.

Fig. 32. *E. albula* f. *albula* Cramer ♂, Teffé, R. Amazon, April 20, 1920, in coll. author. Wings above white, border of primaries blackish-brown. Wings beneath white, base of costa of primaries yellow.

Fig. 33. *E. amelia* Poey ♂, 10 km. south of Pinar del Rio, Cuba, Sept. 12–23, 1913, in coll. Amer. Mus. Nat. Hist. Wings above white, borders blackish-brown. A blackish-brown discocellular dash on primaries above, often quite faint. Primaries beneath pearly white, yellow dusted with fuscous on costa and apex. Secondaries beneath yellow dusted with fuscous, with diffuse fuscous markings. Both wings beneath with two discocellular spots, the upper the larger.

Fig. 34. *E. pseudomorpha* Klots holotype ♂, Bolivia, S. A., in coll. Acad. Nat. Sci. Phila., Pa. Upper side of wings yellow, border of primaries brownish-black. Wings beneath yellow, secondaries deeper than primaries, marginal line of primaries and markings of secondaries bright red.

Fig. 35. *E. albula* f. *tapeina* Bates ♂, Sao Paulo, Brazil, in coll. author. Wings above creamy white, border of pri-

maries brown. Primaries beneath white, costa, apex and outer margin ochraceous yellow. Secondaries beneath ochraceous yellow, with diffuse brown markings. This is the extreme form. Many specimens have light yellow beneath instead of ochraceous, with the markings correspondingly fainter.

Fig. 36. *E. nicippe* Cramer ♂, Gainesville, Fla., U. S. A., Sept. 29–Oct. 2, 1914, in coll. author. Wings above orange, borders and discocellular spot of primaries blackish-brown. Primaries beneath light orange, yellow along costa, apex and outer margin, whitish along inner margin, with brown markings. Secondaries beneath yellow with brown and fulvous markings.

Fig. 37. *E. nicippe* Cramer ♀, Scranton, Pa., U. S. A., in coll. author. Wings above light brownish-orange. Wings beneath colored as in male.

Fig. 38. *E. nicippe* f. ♀ *flava* Strecker ♀, Indiana, U. S. A., Henry Edwards Coll., in coll. Amer. Mus. Nat. Hist. Wings above yellow, borders brown. Primaries beneath yellow, reddish-brown on costa and apex. Secondaries beneath reddish-brown with lighter markings. Some specimens have the reddish-brown replaced by light yellowish-brown.

Fig. 39. *E. pyro* Godart ♂, Port au Prince, Haiti, May 2, 1922, in coll. Amer. Mus. Nat. Hist. Wings above orange, borders blackish-brown. Primaries beneath yellow, distally tinted with orange, markings fuscous to brown, a red terminal line. Secondaries beneath yellow with brown and fulvous markings. Females have the marginal borders of the wings above more diffuse internally and have a discocellular spot on the primaries above.

Fig. 40. *E. pyro* f. *hyona* Menetries ♂, Petionville, Haiti, Jan. 24–29, 1912, in coll. Amer. Mus. Nat. Hist. Primaries above orange, borders brownish-black. Secondaries above with basal two-thirds irregularly yellow, terminal third orange with brownish-black border. Wings beneath as in *pyro*, Fig. 39.

Fig. 41. *E. messalina* Fabricius ♂, Prov. Oriente, Cuba, Aug. 10–22, 1925, in coll. author. Wings above white, borders brownish-black. Primaries beneath white, base of costa pink, costa, apex and outer margin narrowly

yellow, markings blackish-brown. Secondaries beneath light yellow, markings brown.

Fig. 42. *E. messalina* Fabricius ♀, Prov. Oriente, Cuba, Aug. 10–22, 1925, in coll. author. Wings above colored as in male, the apical spot on the secondaries beneath showing through. Primaries beneath as in male, the subapical spot larger. Secondaries beneath colored as in male, except for a large purplish-pink apical spot.

Fig. 43. *E. portoricensis* DeWitz ♂, Coamo Springs, Porto Rico, July 26–27, 1914. Wings above yellow, borders blackish-brown. Wings beneath slightly lighter yellow, markings brown except for apical spot on secondaries which is pinkish, and larger in female.

Fig. 44. *E. deva deva* Doubleday ♂, Novo Friburgo, Brazil, in coll. author. Wings above light yellow, border of primaries blackish-brown. Markings of secondaries beneath show through. Wings beneath pale yellow, reddish on margins, spots and markings red and brown.

Fig. 45. *E. deva chilensis* Blanchard ♂, La Rioja, Argentina, in coll. author. Colors as in *deva deva,* in general paler throughout.

Fig. 46. *E. reticulata* Butler ♂, Ecuador, in coll. author. Wings above orange yellow, border brownish-black. Markings of secondaries beneath show through. Primaries beneath orange at costa, shading gradually to whitish-yellow on inner margin, a narrow red line on apical margin, discocellular spot blackish-brown. Secondaries beneath ochraceous yellow with pinkish-brown reticulations and spots.

Fig. 47. *E. adamsi* Lathy ♂, Dunrobin Distr., Mandeville, Jamaica, B. W. I., Nov. 28, 1919, in coll. Amer. Mus. Nat. Hist. Wings above white, borders brownish-black. Primaries beneath yellow, whitish on inner margin, with reddish markings on costa and apex. Secondaries beneath ochraceous yellow with reddish-brown reticulations and markings. In the plate the borders of the upper side of the wings show through in the figure of the under side. For ♀ see Fig. 100.

Fig. 48. *E. ecuadora* Hewitson ♂, Gerazugh, Ecuador, in coll. Amer. Mus. Nat. Hist. Wings above white, borders blackish-brown, apical patch on secondaries orange. Wings beneath yellowish, secondaries slightly deeper in color, with reddish markings.

Fig. 49. *E. gratiosa* Doubleday & Hewitson ♂, Villavicencio, Colombia, Jan., 1927, in coll. author. Primaries above yellow, border blackish-brown. Secondaries above white, border blackish-brown, apical patch orange yellow. Wings beneath light yellow with brownish-red markings. In some specimens the markings beneath are bright red.

Fig. 50. *E. gratiosa* ♀, Obidos, R. Amazon, Brazil, Sept. 12, 1919, in coll. author. Wings above yellowish-white, the primaries with more yellow than the secondaries, border blackish-brown. Wings beneath as in male. Some specimens have the primaries bright yellow, but the secondaries are always of a lighter yellow. Other specimens are almost pure white above, and correspondingly lighter in coloring beneath.

Fig. 51. *E. boisduvaliana* Felder ♂, Turrialba, Costa Rica, in coll. author. Wings above yellow, borders brownish-black, secondaries suffused with orange apically. Wings beneath yellow with reddish and reddish-brown reticulations and markings.

Fig. 52. *E. boisduvaliana* Felder ♀, Turrialba, Costa Rica, in coll. author. Wings above light yellow, borders brownish-black. The markings of the secondaries beneath show through on the figure of the upper side. Wings beneath as in male.

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Fig. 54. *E. arbela graduata* Butler ♂, R. Amazon, Brazil, Jan. 7, 1920, in coll. author. Primaries above light lemon yellow, secondaries above white apically suffused with orange yellow, borders of both wings brownish-black. Wings beneath light yellow with markings light reddish, very pale.

Fig. 55. *E. arbela elsia* Klots holotype ♂, 28 km. east of Bogotá, Colombia, in coll. author. Wings above white, borders blackish-brown, secondaries apically suffused with orange yellow. Wings beneath yellowish-white, faintly marked with reddish.

Fig. 56. *E. x. xanthochlora* Kollar ♂, Villavicencio, Colombia, Feb., 1927, in coll. author. Wings above yellow, borders blackish-brown. Wings beneath yellow, markings reddish-brown and fuscous.

Fig. 57. *E. xanthochlora pomponia* Hopffer ♂, San Ramon to Pueblo Pardo, Chanchamayo Distr., Peru, June 17, 1920, in coll. Cornell U. Wings above and below as in *x. xanthochlora*.

Plate III. All figures × 2/3

Fig. 58. *E. xanthochlora pomponia* Hopffer ♀, Col. Perené, Peru, June 15, 1920, in coll. Cornell U. Wings above lighter yellow than male. Wings beneath yellow, apical markings on primaries and apical patch on secondaries bright red, other markings reddish-brown.

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Fig. 60. *E. m. mexicana* ♀, Oklahoma, U. S. A., Aug. 6, in coll. author. Wings above yellowish white, border dark brown. Primaries beneath white suffused with yellowish. Secondaries beneath light yellow, with reddish markings.

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Fig. 62. *E. mexicana bogotana* Felder ♂, San Miguel, Colombia, in coll. Amer. Mus. Nat. Hist. Wings above yellowish white, borders dark brown. Primaries beneath white narrowly margined with yellowish, secondaries beneath yellow, markings on both wings beneath reddish-brown and reddish.

Fig. 63. *E. mexicana bogotana* Felder ♀, Cartago, Costa Rica, in coll. author. Wings above yellowish-white, borders dark brown. Primaries beneath white, marginally

tinted with yellow; costa, apex and outer margin narrowly red. Secondaries beneath yellowish, reticulations and markings red.

Fig. 64. *E. salome* f. *salome* Felder ♂, 28 km. east of Bogotá, Colombia, in coll. author. Wings above yellow, borders dark brown; costal and outer areas of secondaries suffused with orange. Wings beneath yellow, secondaries suffused and marked with ochraceous reddish.

Fig. 65. *E. salome* f. *limoneus* ♂, Mexico, in coll. author. Wings above yellow with borders dark brown, orange suffusion of secondaries limited to an apical patch. Wings beneath as in *salome* f. *salome* markings sometimes red.

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Fig. 67. *E. salome* Felder ♀, Cartago, Costa Rica, in coll. author. Wings above light yellow. Wings beneath as in *salome* f. *salome* ♂, Fig. 64.

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Fig. 69. *E. proterpia proterpia* Fabricius ♀, Cartago, Costa Rica, in coll. author. Wings above light brownish-orange, borders and markings along veins dark brown. Wings beneath as in male.

Fig. 70. *E. proterpia watsonia* Klots paratype ♂, Riobamba, Ecuador, in coll. author. Wings above bright orange, costa and veins brownish-black, clouding fuscous. Wings beneath as in *p. proterpia*, except that there is more difference in coloring between the primaries and secondaries.

Fig. 71. *E. proterpia watsonia* Klots allotype ♀, Ecuador, in coll. Amer. Mus. Nat. Hist. Coloring as in *p. proterpia* ♀, except that the fuscous dusting on the wings above is heavier and the secondaries beneath are lighter yellow.

Fig. 72. *E. gundlachia* Poey ♂, Cartago, Costa Rica, in coll. author. Wings above colored as in *proterpia*. Primaries beneath light orange, costa narrowly brown, apex more broadly brown. Secondaries beneath heavily reticulated with light brown.

Fig. 73. *E. gundlachia* Poey ♀, Cartago, Costa Rica, in coll. author. Wings above lighter, more brownish orange than in male. Secondaries beneath usually more heavily reticulated with brown than in male. Some specimens have a dark brown apical patch on the secondaries above, and the tips of all the veins dark brown.

Fig. 74. *E. lisa lisa* Boisduval & Leconte ♂, DeFuniak Springs, Fla., U. S. A., Oct. 17–19, 1914, in coll. author. Wings above yellow, borders dark brown. Wings beneath yellow, inner margins of primaries pearly, costa and outer margins with a narrow pink line, markings fuscous, except for apical patch of secondaries which is pinkish-orange.

Fig. 75. *E. lisa lisa* ♀, Flushing, Long Island, N. Y., in coll. author. Wings above light yellow, borders dark brown. In many specimens the wings above are pinkish-white. Wings beneath as in male, markings heavier.

Fig. 76. *E. lisa* f. *clappi* Maynard ♂, Cartago, Costa Rica, in coll. author. Coloring as in *lisa lisa* male, markings beneath less distinct.

Fig. 77. *E. lisa* f. ♀ *alba* Strecker ♀, Kendal Distr., Manchester, Jamaica, B. W. I., Nov. 16, 1919, in coll. author. Wings above white, borders dark brown. Primaries beneath light yellow, inner margin white, costa and outer margin with a narrow pink line, markings fuscous. Secondaries beneath light yellow, apical patch and narrow line on outer margin pink, markings and dusting fuscous. All sorts of intergrades occur between *lisa* females which are normally yellow above and f. ♀ *alba* which are pure white above.

Fig. 78. *E. lisa euterpe* Menetries ♂, St. Thomas, Virgin Islands, Nov. 20, 1920, in coll. author. Coloring as in *lisa lisa* male, markings beneath less distinct.

Fig. 79. *E. dina dina* Poey ♂, Santiago, Cuba, Aug. 9, 1925, in coll. author. Wings above orange yellow, borders dark brown, secondaries outwardly suffused with orange. Wings beneath lighter orange yellow, paler on inner margin of primaries, markings fuscous.

Fig. 80. *E. dina* f. ♀ *citrina* ♀, Prov. Oriente, Cuba, May 10–22, 1925, in coll. author. Wings above more lemon yel-

low than male, Fig. 79, borders dark brown, orange suffusion on secondaries sharply limited apically and marginally. Wings beneath light yellow, paler on inner margin of primaries, reddish-orange at apices of both primaries and secondaries, markings fuscous.

Plate IV. All figures × 2/3

Fig. 81. *E. dina westwoodi* Boisduval ♂, Florida, Costa Rica, in coll. author. Wings brighter orange yellow than in *d. dina,* borders dark blackish-brown, a deeper orange suffusion at outer margin of secondaries. Wings beneath yellow, primaries paler at inner margin, some very faint fuscous markings.

Fig. 82. *E. dina westwoodi* Boisduval ♂, Jalapa, Mexico, Nov. 3, 1912, in coll. author. Wings above orange yellow, border dark brown, a slightly deeper orange suffusion at outer margin of secondaries. Wings beneath yellow, primaries lighter than sceondaries, secondaries with fairly heavy fuscous markings.

Fig. 83. *E. dina* f. *memulus* Butler ♂, San Lorenzo, Repub. Domin., W. I., June 27–29, 1915, in coll. Amer. Mus. Nat. Hist. Wings above yellow, border dark brown, a slight marginal orange suffusion on secondaries. Wings beneath yellow, inner margin of primaries whitish, faint fuscous markings on secondaries.

Fig. 84. *E. dina* f. *memulus* Butler ♀, Petionville, Haiti, Jan. 24–29, 1922, in coll. Amer. Mus. Nat. Hist. Coloring both above and below as in *dina* f. ♀ *citrina,* Fig. 80.

Fig. 85. *E. dina* f. *memulus* Butler ♂, orange form, San Lorenzo, Repub. Domin., W. I., June 27–29, 1915, in coll. Amer. Mus. Nat. Hist. Wings above bright orange, borders brownish-black. Wings beneath orange yellow, lighter on inner margin of primaries, with faint fuscous markings.

Fig. 86. *E. dina parvumbra* Kaye ♂, Jamaica, B. W. I., no. 4508 in coll. Amer. Mus. Nat. Hist. Wings above light yellow, border dark brown. Wings beneath light yellow, inner margin of primaries whitish, markings brownish fuscous.

Fig. 87. *E. dina leuce* Boisduval ♂, Villavicencio, Colombia, Jan., 1927, in coll. author. Wings above lemon yellow, bor-

ders dark brownish-black. Wings beneath yellow, inner margin of primaries whitish, faint fuscous markings.

Fig. 88. *E. dina leuce* Boisduval ♀, Obidos, Brazil, Aug. 23, 1919, in coll. author. Coloring above as in male. Coloring beneath as in male, except that there is reddish-orange on the apices of both primaries and secondaries, and the fuscous markings are heavier.

Fig. 89. *E. nise nise* Cramer ♂, Lima, Peru, May 9, 1920, in coll. Cornell U. Wings above lemon yellow, borders dark brown. Wings beneath yellow, inner margins of primaries lighter, faint markings fuscous.

Fig. 90. *E. nise nise* Cramer ♂, Corumbá, Matto Grosso, Brazil, Dec. 14–15, 1919, in coll. Cornell U. Coloring as in Fig. 89, wings above a trifle more orange yellow.

Fig. 91. *E. nise stygma* Boisduval ♂, Peru, in coll. author. Wings above yellow, slightly tinted with orange, borders dark brown, secondaries outwardly suffused with light orange. Primaries beneath light yellow, paler at inner margin, costa narrowly red, apex broadly red. Secondaries beneath dull orange yellow, outer margin and spot on apex reddish, marking and discocellular dots fuscous.

Fig. 92. *E. nise stygma* Boisduval ♀, Peru, in coll. author. Coloring as in male, reddish and fuscous markings beneath more intense.

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Fig. 94. *E. nise perimede* Prittwitz ♀, Truxillo Distr., Honduras, in coll. author. Wings above slightly lighter yellow than in male. Markings on secondaries beneath more distinct; sometimes a pinkish apical spot.

Fig. 95. *E. v. venusta* Felder ♂, Grenada, B. W. I., July 13, 1927, in coll. author. Primaries above slightly orange yellow, secondaries above yellowish-white, borders dark brown. Wings beneath pale yellow, primaries whitish on inner margin, secondaries with fuscous markings.

Fig. 96. *E. v. venusta* Felder ♂, Roseau Valley, Dominica, B. W. I., Nov. 18, 1920, in coll. Cornell U. Primaries above lemon yellow, secondaries above paler yellow.

Wings beneath as in Fig. 95, fuscous markings fainter.

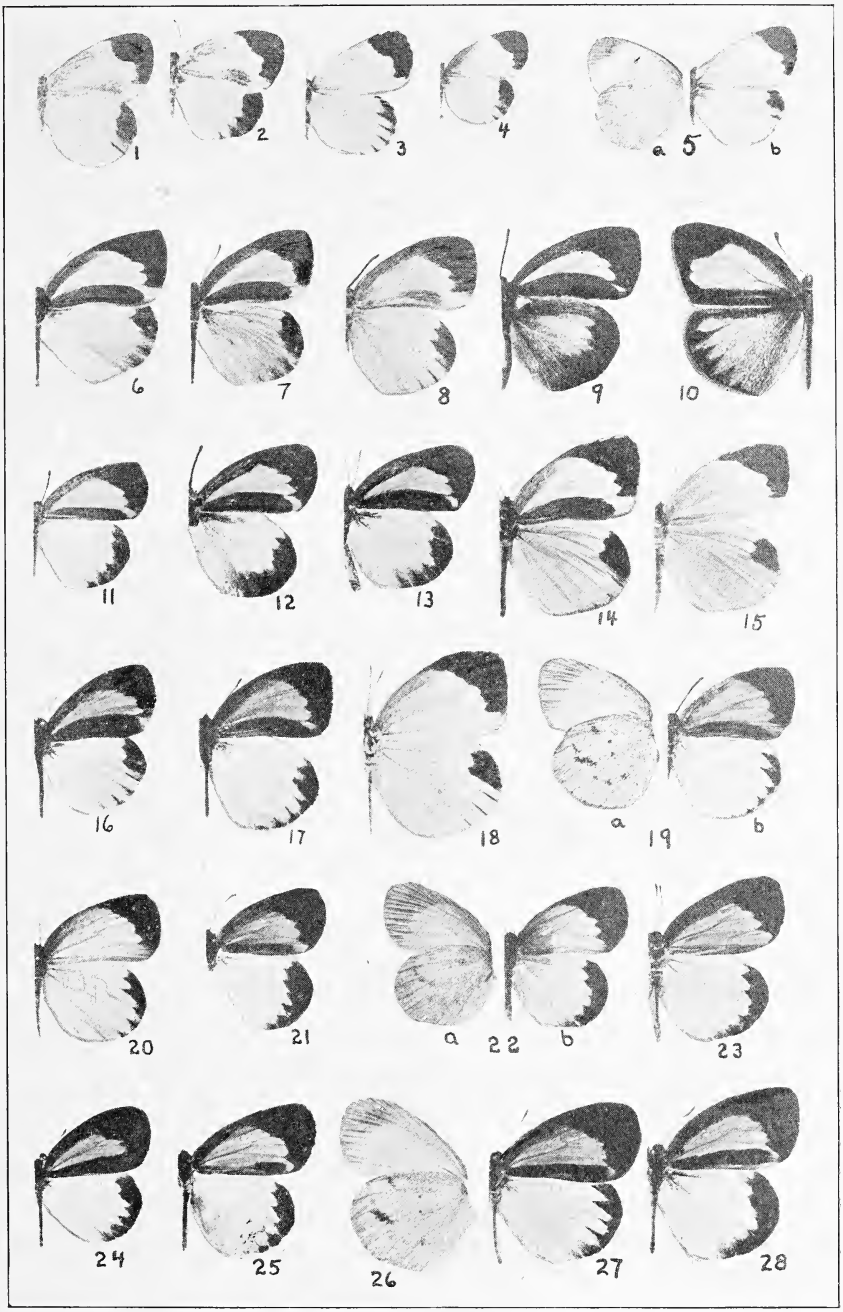
Fig. 97. *E. venusta* Felder ♀, R. Amazon, Brazil, in coll. author. Primaries above yellowish-white, secondaries above white, border dark brown. Primaries beneath yellowish-white, costa, apex and outer margin tinted with yellow. Secondaries beneath white, marginally tinted with yellow, discocellular dots and some very faint markings fuscous.

Fig. 98. *E. venusta* Felder ♀, Castries, St. Lucia, B. W. I., Sept. 10–12, 1919, in coll. Cornell U. Wings above yellowish-white, border dark brown. Wings beneath as in Fig. 97.

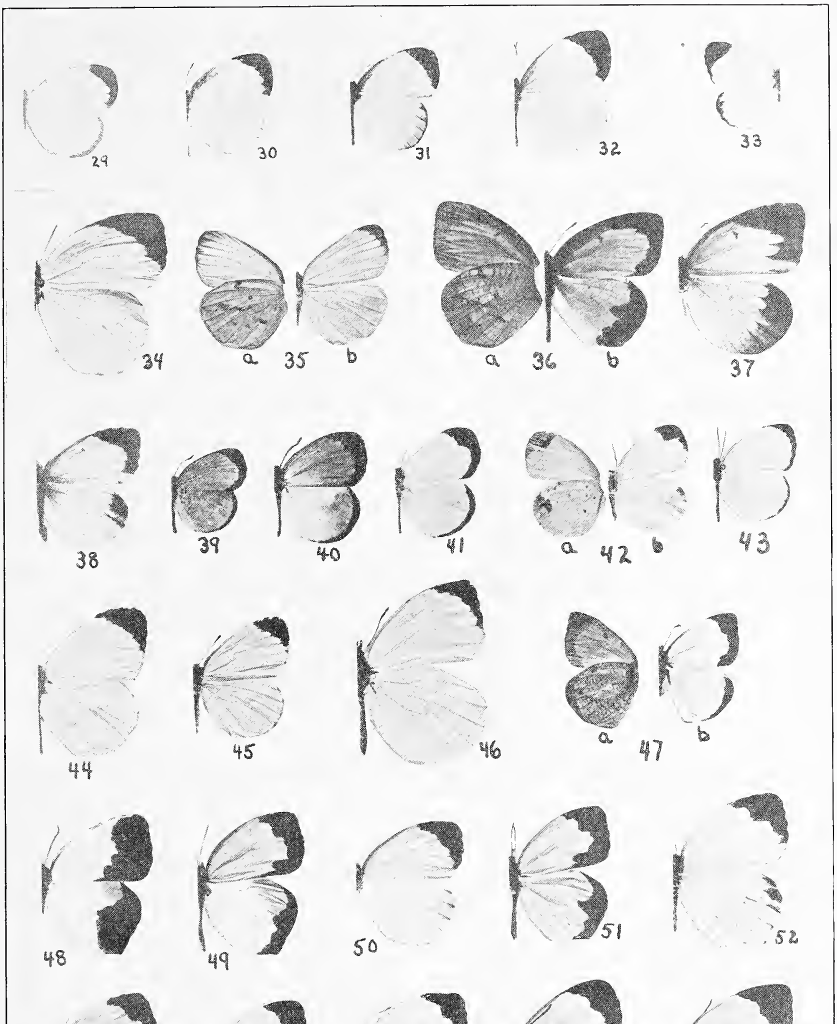
Fig. 99. *E. venusta limbia* Felder ♂, Bolivar, Venezuela, Aug. 22, in coll. author. Primaries above yellow, secondaries above white, border dark brown. Wings beneath light yellow, secondaries with discocellular dots and very faint markings, fuscous.

Fig. 100. *E. adamsi* Lathy ♀, Jamaica, in coll. author. Wings beneath light yellow, slightly tinted with ochraceous, inner margin of primaries whitish, apex of primaries and whole of secondaries reticulated with reddish ochraceous.

Fig. 101. *E. pseudomorpha* Klots holotype ♂, Bolivia, in coll. Acad. Nat. Sci., Philadelphia. Color description under Fig. 34.



Pl. I. All figures × 1.



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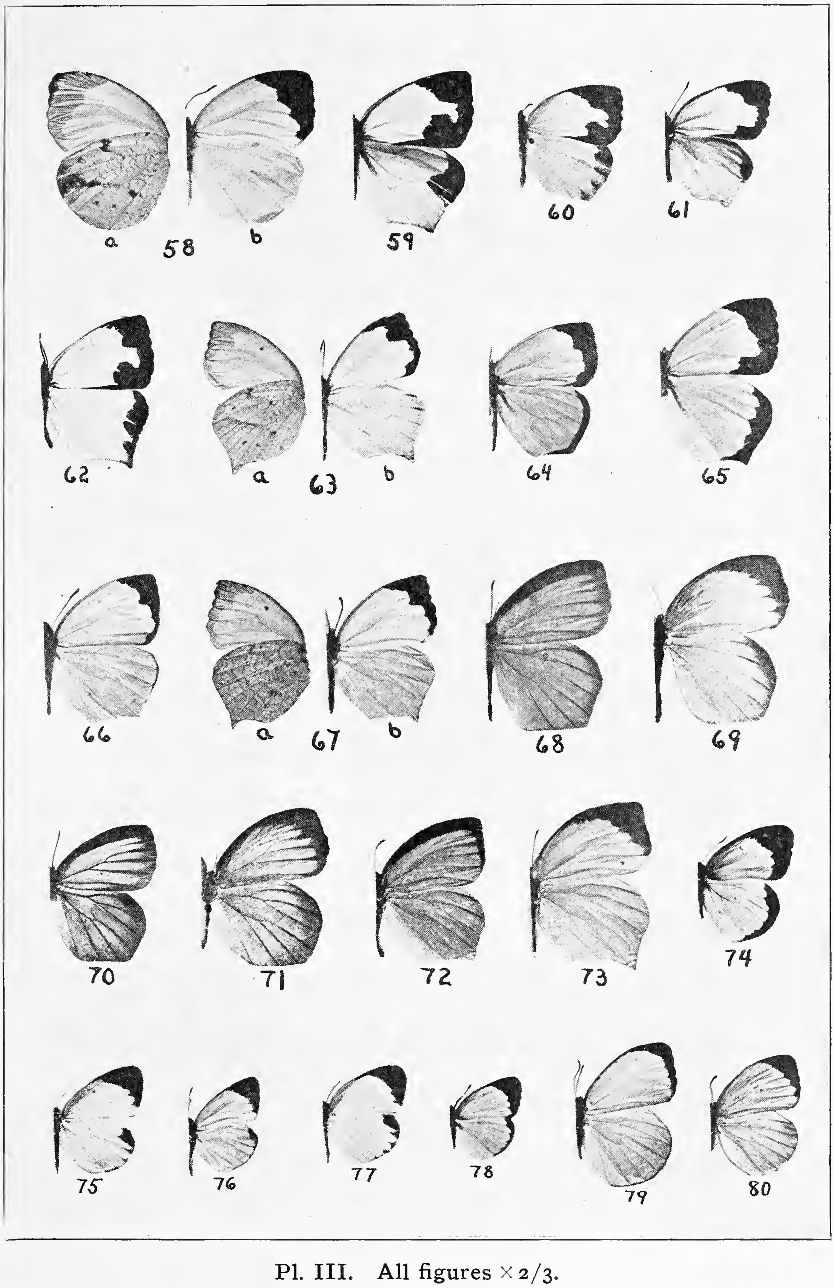
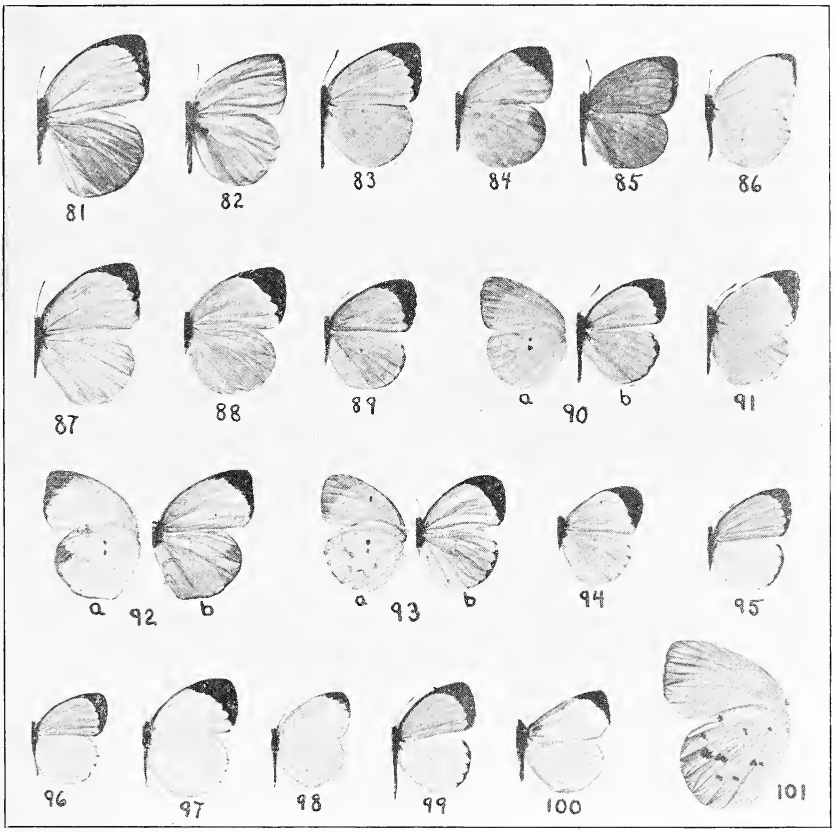


Pl. III. All figures × 2/3.



Pl. IV. All figures × 2/3.

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The Biology of the White Pine Weevil, Pissodes Strobi (Peck), and A Study of Its Insect Parasites from an Economic Viewpoint

BY

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THE BIOLOGY OF THE WHITE PINE WEEVIL, PISSODES STROBI (PECK), AND A STUDY OF ITS INSECT PARASITES FROM AN ECONOMIC VIEWPOINT*

Raymond L. Taylor

General Introduction

For a long period, the white pine weevil has been a serious enemy of the white pine, *Pinus strobus;* and this preferred food plant is an exceedingly valuable tree wherever, and whenever, it has occurred. The American colonists were familiar with the virtues of white pine and depended upon its excellent timber for their ships, homes and furniture; it was the chief export of New England; it was, indeed, so well thought of that in Massachusetts the white pine was emblazoned upon both an issue of coinage and a colonial banner. The colonists did not notice the weevil, however, and under the natural conditions of virgin mixed forests, *Pissodes* could not have been as abundant as it is now.

White pine, with its rapid growth, its high yield and its great range of utility, is needed to-day more than formerly and, in response to the stimulus of a great demand, this pine has been so extensively planted in pure stands that, paradoxically, the entire supply of *Pinus strobus* has suffered a great decrease in quality and quantity. This is readily appreciated when it is realized that the weevil, like any enemy of a given food plant, tends to become more numerous when concentrations of its food are made available over wider areas.

Of all the enemies of the white pine, the two which unquestionably are most important are the white pine bliter rust, *Cronartium ribicola* Fischer and the white pine weevil, *Pissodes strobi* (Peck). Since it has been a debatable point which of these is the more pernicious, it may not be amiss, briefly, to compare them. While the blister rust is eventually fatal, its distribution is not coincident with the range of the pine and it is of particular significance that the thorough eradication of nearby *Ribes* offers a positive and complete control. The weevil, on the other hand, should be considered

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the more destructive[1] because its ravages, while not fatal, are responsible for an enormous loss in prime timber; it occurs, in general, wherever white pine is found; and there is no single positive control nor any likely possibility of its extermination. The injuries caused by this curculio are so obvious that the feasibility of further plantings of white pine has been questioned by many foresters.

Pissodes strobi has been known for more than a century; the amount of work done upon it is large and there have resulted therefrom, a number of suggestions for its control. Many of the methods suggested are much too expensive or otherwise inexpedient. The rôle of its parasites, however, while usually conceded to be important, has been neglected until recently. This study was undertaken as an attempt to fill this gap in the biology of *Pissodes.* It is realized that only a beginning has been made, but it is hoped that the conclusions derived from the data secured may be of value. The major portion of this paper deals with the results of observations and the breeding of insect parasites from September, 1926, to May, 1929, near Forest Hills, Boston, Mass., and environs.[2] Some observations have been made at Petersham, Mass., and at Boyce, Clark County, Va. Most of the field observations were made at the Stony Brook and Blue Hills Reservations of the Massachusetts District Commission near Roslindale and Milton; a majority of the parasite material was collected there. Material has been studied from other states, *viz.,* Maine, New Hampshire, Vermont, Rhode Island, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Ohio and Michigan.

This paper divides naturally into the following parts:

A. THE HOST

I. The Biology of the White Pine Weevil

This part is primarily historical and comprises a summation of the work done on the life history of the pest and the various control measures advocated. An attempt has been made to unify and

[1] Britton (1920) states that the white pine weevil causes more damage to young pines in Connecticut than any other agent. Blackman (1916) considers that ". . . the insect is by all odds the most serious enemy of the white pine in New York and adjacent states."

[2] Milton, Dedham, Brookline, Newton, Winchester, Stoneham, North Beverly and Hingham.

arrange the data compiled from the various sources for ready comparison. Criticisms have been made, corroborations and disagreements with published work are included, and some new observations and data have been added in their logical position. The intention has been to bestow credit where it belongs and if there are omissions of this sort they are unintentional.

B. THE INSECT PARASITES

I. Breeding Methods, Apparatus, and General Data Secured

This section is an arbitrary grouping of what the title states. Data pertaining to the parasites collectively are tabulated here for emphasis and convenience.

II. The Several Parasites

Here are included the biologies of the forms definitely parasitic upon *Pissodes strobi,* in so far as they were determined, a list of other parasites obtained, and a list of those obtained by other workers from similar material but not obtained in the course of this study. Predators and miscellaneous agents in the natural control of the weevil are briefly discussed. Data which are specific rather than collective may be found in this section under the headings of the several parasites.

III. A Discussion of the Feasibility of Applied Parasite Control of Pissodes strobi

This subject is made a separate section because of its economic importance. It is based directly upon what is given in the preceding two parts. The practical significance of the findings of this study is dealt with and a speculation concerning the possibilities in the importation of foreign forms is made.

All summaries and bibliographies are grouped and appended.

A. THE HOST

I. The Biology of the White Pine Weevil

Introduction

As pointed out, the white pine weevil is the most serious enemy of *Pinus strobus* in most localities where the tree occurs. It has been conservatively estimated that in New York and New England from 70 to 90 per cent of all white pines are weeviled before they are 15 years old.[3] Though the trees are not killed, save in very rare

[3] Graham (1926), p. 6.

instances, they are spoiled both esthetically and commercially. The damage, briefly, consists of the production of crooked trees as a direct result of the death of the leaders. The depredations of the weevil are controlled in the field by a series of interacting factors such as insect parasites, birds, insect predators, and other "ecological" agents; limitations in the food supply afforded by the leaders result in the starvation of a very high percentage of the early instar weevil larvae. Suggestions of many types of artificial control have been made in the literature and these will be taken up at their proper place.

Synonymy

Rhynchaenus strobi	—	Peck (1817)
Pissodes nemorensis	—	Say (1831)
Pissodes strobi	—	Say (1831)
Pissodes strobi	—	Say (1859)
Pissodes strobi	—	Gemminger and Harold (1871)
Pissodes strobi	—	Le Conte and Horn (1876)
Pissodes strobi	—	Hopkins (1911)
Pissodes strobi	—	Blatchley and Leng (1916)

Pissodes strobi has been confused with *P. webbi* Hopk. (Champion, 1902), *P. fiskei* Hopk. (Packard, 1890) in catalogs, and *P. approximatus* Hopk. and *P. affinis* Randall, as well as *Hylobius pales* Boh., have been mistaken for it both in the literature and by collectors.

History

In a very interesting record in the Massachusetts Agricultural Repository and Journal for January, 1817, Professor W. D. Peck of Harvard University gives an account of a weevil, *Rhynchaenus strobi*, ". . . which destroys the leading shoot of the Weymouth Pine."

No one interested in the white pine weevil should neglect to read Peck's description of the destruction caused by this native pest, and his style, moreover, is a refreshing change from that of some of our present day technical papers. In this account, which is the earliest authentic record, the curculionid is described, figured, and named, while an unknown ichneumonid parasite is also figured. This account is further interesting in that it is one of the first in which any injurious native insect was described.

Since 1817 the weevil has been studied by a number of entomologists, notably Harris (1841), Fitch (1857), who worked out the general facts of the life cycle, Packard (1890), who elaborated upon this knowledge, Hopkins (1907), Peirson (1922), Graham (1926), MacAloney (1926), and Barnes (unpublished). Felt (1906, 1915), Britton (1920), and others have made contributions.

Hopkins achieved a very well done piece of work on the biology of Pissodes and was the first to suggest that the parasites be salvaged from pruned leaders. Peirson handled the biology of the weevil adequately enough for his purpose; Graham, has given *Pissodes* a very lucid and inclusive treatment and has made valuable experiments on its control; both Graham and Peirson have made notes on the parasites; MacAloney's work corroborated Graham on control to a large extent and he was the first to surmise how the weevil attains the white pine leaders; Barnes has made some very interesting studies, primarily along anatomical and physiological lines.[4]

It is apparent that this curculionid has long been destructive and has merited the considerable amount of attention it has received. Under the present conditions of small wood lots and much diminished natural stands of *Pinus strobus* in process of replacement by new, and frequently pure, plantations, it is likewise apparent that, unless adequate control measures are found, the further increase of the weevil may be expected.

Distribution

In general, *Pissodes strobi* is found coincident with the natural range of white pine. It is widespread and abundant throughout the southeastern portion of Canada, New England, New York, the Appalachian forest zone, Michigan, and parts of Wisconsin and Minnesota. It is found sporadically, or occasionally, in other states such as Indiana, Illinois, Iowa, and Ohio, and in scattered localities, westward to the Rockies. It is most important in New England, the states bordered by the Great Lakes, and Maryland.[5] It is of interest that large quantities of young white pines have been exported to

[4] Some work with parasitism has been done by Barnes and his parasite distribution data will, by his offer and permission, be included in this paper. MacAloney has also bred out a number of weevil parasites. His similarly unpublished parasite distribution data will, by his offer and permission, be included herein.

[5] A map may be found in Hopkins's (1911) paper.

Japan within the past ten years and that the plantations there are now heavily infested with *Pissodes strobi*.

Host Plants

Pinus strobus is by far the favored food of the weevil and all other host trees are exceptions to a general preference. *Picea abies* (*P. excelsa*) and *Pinus sylvestris* are commonly attacked. When trees other than *Pinus strobus* are attacked, they often are found to have been mixed with, or adjacent to, infested white pines. It is very probable that native pines and spruces, other than those given in the following table, will be found to be attacked by the white pine weevil.

Other species of the genus *Pissodes* are common on conifers throughout the range of *P. strobi*. *P. approximatus* is found in

TABLE 1
Host Plants of *Pissodes strobi*

Choice	Species	Noted by:	Date
First	White pine .... *Pinus strobus*	* All workers	1817–now
Second	Norway spruce .... *Picea abies*	* Graham,	1926
		Peirson, *et al.*	1922
Commonly	Scotch pine .... *Pinus sylvestris*	* Graham,	1926
		Peirson, *et al.*	1922
Occasionally	Pitch pine .... *P. rigida*	Hopkins	1911
"	Jack pine .... *P. banksiana*	Hopkins	1911
"	Labrador pine .... *P. divaricata*	Blatchley	1916
"	Red pine .... *P. resinosa*	Graham	1926
Infrequently Reported	Japanese pine .... *P. densiflora*	Peirson	1922
"	Himalayan cedar ...... *Cedrus deodara*	Currie	1905
"	Red spruce .... *Picea rubra*	Hopkins	1911
"	White spruce .... *P. glauca*	Peirson	1929
"	[6] Balsam fir .... *Abies balsamea*	Packard	1890
"	[6] Eastern hemlock ... *Tsuga canadensis*	Packard	1890

* Noted in this study.

[6] The records of balsam fir and eastern hemlock as food plants of *Pissodes strobi* have been questioned by Graham (1926) who believes that Packard, in his writings, has confused other species of *Pissodes* with the white pine weevil. No one since has corroborated the record of the former, but Peirson, verbally, has reported the weevil in *Tsuga*.

the thick bark of the trunk, stumps, logs, and the bases of saplings of a number of pines; *P. affinis* has often been taken in similar sites; and *P. nemorensis* is found on the bark of several pines south of Pennsylvania. As might be expected, these and others are occasionally mistaken for the white pine weevil but, if the relative size and general characters do not readily aid in the correct determination, the habits are at once an apt and conclusive means of identification. In the natural range of *Pinus strobus,* only *Pissodes strobi* will be found associated with the terminal shoots[7] (although it may be temporarily or accidentally present on the trunk or laterals).[8]

Character of Injuries

A young white pine with the apical portion brown, dry, and withered, is apt to be a weeviled one; if the shoot is more or less riddled with holes, there can be no doubt about it. With a light infestation, the injury to the leader usually does not extend below the topmost whorl of lateral branches; under ordinary conditions, the destruction of the leader below this whorl is common; in heavy infestations, weeviling may destroy the shoot below the second and even the third whorl. Extreme cases, where the twelfth whorl from the top had been reached, have been noted. It is important to bear in mind that the amount of a year's growth, and hence the height of the leader and the distance between whorls, varies with the stand. Leaders which measure three feet are common in localities favorable for white pine; those at Stony Brook were seldom over 18 inches and often less. It is evident that, if the distance

[7] In California, Hopping (1920) reports a new species, *P. terminalis,* which mines the leaders of *Pinus contorta;* also in the west, *P. sitchensis* Hopk. and *P. engelmanni* Hopk., according to Hopkins (1911), destroy the terminal shoots of *Picea sitchensis* and *P. engelmanni* respectively. All other members of the genus in the U. S., so far as is known, are primarily bark feeders in mature trees.

[8] Peirson (1922) says, "In the original primeval forest that at one time covered New England, the weevil is thought by some entomologists to have lived largely in the mature pines, boring into the sapwood of dying trees and only occasionally attacking the leaders of young pine. . . . To some extent it has probably retained this habit of attacking mature pine and spruce. . . . " If this hypothesis is correct, it follows that some weevils might have been observed reverting to the older habit. No investigator has reported such an observation yet, phylogenetically, the present specialized habit is very probably derived as suggested.

weeviled is rather definite, the loss of a whorl is to a large extent dependent upon the previous vigor of the attacked tree.

Lateral branches are often occupied by a few weevil larvae that have entered from the leader and, in heavy infestations, thirty or more grubs may be found in their basal parts. It is noteworthy that laterals without larval mines are killed as surely as those occupied if the leader has been weeviled to any point below the nodus of that whorl. It is equally striking that, if only four or five larvae mine a leader of average thickness, the death of all that portion above their operations is just as certain as in the cases where the lethal minimum is exceeded, though the extent of injury and the rapidity of destruction may be greater with the larger number of larvae.

It is difficult to estimate the ''average'' number of larvae in a shoot[9] in a typical infestation: An incidental count of grubs in 116 shoots from widely separated localities gave a mean of 25.8. Over one hundred fifty large-sized larvae in a single shoot have been counted. It is apparent that there is usually present a large surplus of weevils over the number necessary to accomplish the destruction of the leader, and all methods of control must reckon with this fact. Indeed, more often than not, there are many more larvae in a terminal shoot than can be supported by the available food supply.

The manner in which the injuries are effected is as follows: From the points of oviposition, which range from the extreme tip of the leader to several feet below the terminal bud cluster, the newly-hatched larvae begin to mine in the cortex, phloem, and cambium. Very quickly, the majority of the larvae burrow downward, and as they grow they consume and occupy all the tissues between the true bark and the xylem. When their food requirements, which Barnes has found to be from .5 to 1 g. per larva, are satisfied, they then bore inward into the wood and excavate a cell in which to pupate. Since the cambium, phloem, and cortex are consumed, and much of the xylem cut across, the leader is killed by a summation of physiological deficiencies.

[9] An easy method of determining the approximate number of weevil larvae in a given series of leaders is to immerse in water each shoot, which has been cut an inch or so below the frontier of weevil advance; as the larvae descend they emerge from the cut end, are drowned, and sink to the bottom of the container where they may be counted. (This method cannot include the larvae which, for various reasons, fail to emerge from the cut end.)

When a leader is destroyed, the laterals of the topmost unweeviled whorl are stimulated to compete for supremacy. If one lateral succeeds in "taking the growth", a characteristic bayonet-shaped trunk results; two laterals, which are equally successful, produce a forked tree; or, commonly, a parity of growth of all the laterals causes a bushy "cabbage pine". Successive weeviling produces various combinations of the above results of the laterals' competitive growth and subsequent "straightening up". Trees, with one initially successful lateral, followed by years of unweeviled growth, may overcome the bayonet-shape tendency but, otherwise, they are rendered worthless for spars or good lumber; the timber, in the cases of repeated weeviling especially, is seriously decreased in value for any use beyond pail and tub stock, inferior box stock, fuel, and the like. It should be evident that the loss in height caused by normal weeviling in any year is always more than the tree would have added since, invariably, more or less of the preceding growth is destroyed as well as the terminal bud cluster. Repeated weeviling may not only bring growth to a standstill but may actually, in extreme cases, shorten the tree annually. MacAloney (1926) reports the case of a 60 year pine, 66 feet tall, which had been weeviled 67 times. The acme in cabbage pines is probably the one noted by Blackman and Ellis (1916) where, after repeated weevilings, 75 or more struggling leaders were observed. The loss of height growth, in terms of all the trees on a given tract, means a consequent retardation of the development of the stand itself and is a factor of great importance in the economics of timber production.

Other less common and less important injuries are suggested by Graham's (1926) note of a secondary injury in increased snow breakage due to the greater capacity of weeviled and bushy trees for holding snow, and the observation by several writers that the adult weevils, when they feed upon emergence, may weaken the tree to some extent. Kellicott (1879) made an observation that weeviled trees are more susceptible to attacks of the pine top moth, *Dioryctria* (*Pinipestis*) (*Nephopterix*) *zimmermani* (Grote) but his "pine weevil," orange larvae, which were found to winter in the larval condition and to feed on the bark of mature trees, are obviously not *Pissodes strobi*. In this study, *Dioryctria zimmermani* was never observed in weeviled leaders.

The first indications of impending injury by *Pissodes strobi* are evident in Massachusetts usually in late April or May when the adults may be found feeding or *in copula* on the terminal bud clusters or on the shoots just below these clusters. Small perforations in the bark, with exuding droplets of clear pitch, may be noted. These feeding and egg-laying punctures later become less apparent as the pitch glazes over and becomes white. The dark green bark gradually turns brown and becomes thin and smooth-looking as the whole shoot is increasingly desiccated. When the thin, smooth bark assumes a mahogany color, the needles begin to turn a lifeless, light brown. Birds may tear at the paper-thin bark in search of the larvae just underneath and may expose the dark brown frass and whitish wood fibers characteristic of weevil work. Bulges under the bark in July indicate that the larvae are excavating pupal cells. From late July to early September, circular exit holes, about 2.5 to 3 mm., often with frass and wood chips sifting out, appear in the mahogany bark. By this time the whole top of the tree is dead and the needles, which have browned during the summer, begin to fall in September. The exact point in the leader where weeviling has ceased may be readily determined by the difference in the color and the appearance of the bark. During the winter and the following year, the dead shoot bleaches while the laterals compete for the replacement of the leader. If the old terminal shoot is well riddled, it usually breaks off, otherwise, it remains a decaying snag.

The injury to Scotch pine or to Norway spruce is accomplished in the same way as in the white pine, though the evidences of weevil infestation are not so striking, the general wilted appearance of the leader is a fair indication (if frost injury is not suspected) and the presence of exit holes make the cause of the condition certain.

Conditions of Injury

The white pine weevil is remarkably consistent in its choice of conditions for repeating the life cycle and this specificity indicates the operation of physical and physiological factors to a degree not yet completely measured. It is the young pines, principally, which are attacked by the insect. Graham (1926) puts the first attack of the weevil at a tree age of five to seven years, or when the pine is about two to three feet high, with the maximum susceptibility when the tree is 12 to 18 years old, and a virtual immunity to attack when the tree attains an age of 25 to 30. Peirson (1922) states that "the majority of weeviling in pure open pine plantations occurs when the pines are between the heights of two and twelve feet." MacAloney (1926) agrees with the foregoing and has found that "at a height of 60 feet weeviling is practically negligible." He has found, however, occasional infested leaders at 88 feet. The lower limit of range is nursery stock, as noted by Britton (1920). It was noted, incidentally, on the Stony Brook tract that, in agreement with the above, weeviling under four feet was exceptional and that the maximum infestation occurred at seven to twelve feet or about ten years old.[10]

There seems to be no doubt that, within a given height or age class, the weevil prefers the more vigorous or rapidly growing leaders, as pointed out by Graham (1926). This preference obviously results favorably to the insect, when the greater amount of material to be mined in a longer terminal shoot (before the whorl is reached) is considered. The factors responsible for such a delicate choice have not been discovered but the tendency is apparent.

The matter of tree selection by *Pissodes,* in general, may be considered as the resultant of a number of physiological factors including positive phototropism and negative geotropism. Holding this, it may be further considered, logically, that the majority of weeviled trees should be the tallest trees of a plantation, these, too, where the light is best. The only reasonable exception to this can be where the weevil is so abundant that the trees tend to be infested *en masse* and, in this case, the majority of the weeviled trees are in the common height class solely because the taller trees are in the minority. Thus, such cases in no way nullify observations that, in moderate infestations, the (highest) trees receiving the most insolation are the chief targets of weevil oviposition. This habit of being attracted to the best trees causes more harm than the damage to the optimum trees themselves, inasmuch as the development of the whole stand tends to be retarded by a slowing down of the natural thinning out process. In this manner, the slower growing trees, instead of being surpassed, manage to take even terms with the previously more vigorous but now weeviled trees, and the rate of growth for the stand as a whole is reduced by the retardation, or even stagnation, of a natural competitive growth.

The relative importance of the height of the trees, their rate of growth, and the manner in which the weevils reach the leaders, have been discussed by several writers: Peirson (1922) assumed that the height of the pine was the more important factor. He based this view upon the assumption that the weevils fly over a

[10] These figures refer, of course, to pines whose yearly growth is substantially less than is the case with those growing at a higher elevation and farther from the seacoast, as at Petersham, Mass.

stand and are attracted by the tallest trees. Graham (1926), while he has no evidence to disprove this assumption, relates banding experiments which indicate that the weevils crawl up the trunk; his field observations would seem to show that a rapidly-growing, shorter tree was preferred to a slower-growing, taller tree.[11] MacAloney (1926) also banded trees and reasoned with acumen that both Graham and Peirson are correct as far as they have gone. He says, "Thus we find that the weevils may get to the leader by one of three ways, crawling up the stem from the ground, flying to any part of the tree itself and then crawling up the rest of the way, and by flying directly to the leader itself." Barnes has corroborated this hypothesis rather conclusively since he has found that the weevils reach the leaders just as described. The matter of which is more important in weevil attraction, height or rate of growth of the tree, is still unsettled.

The rate of increase in *Pissodes* infestation from year to year is a phase of interest to all workers, economic or otherwise, who are naturally concerned in what may be expected the following season in a weeviled tract. Peirson (1922) states that, "As a general rule the percentage of trees weeviled each year is approximately the same . . . " but some of the data gathered by others do not corroborate this. MacAloney (1926) reported data as follows:

	1925	*1926*
Check plots around Plot 1	37%	57%
Check plots around Plot 2	21%	35%

or rates of 1.54 and 1.66 times the 1925 infestation, respectively.

These check plots may have been, and probably were, influenced by the plots where the trees were banded but an increase of infestation in 1926 over 1925 is evident. In the banded plots, however, there was a "substantial *decrease* in per cent of weeviling over the previous year's infestation."[12] Graham's (1926) data, expressed

[11] The frequent condition is that rapid growth and superior height are concomitant, and this is conspicuous, of course, in even aged stands.

[12]	*1925*	*1926*	*decrease*
Plot 1	51%	12%	39%
Plot 2	27%	15%	12%

graphically, not in per cents but in number of trees per acre, ran as follows:

Infestation	1910	about	18 trees			
"	1911	"	105 "	or	5.83 × that of	1910;
"	1912	"	66 "	"	.62 × " "	1911;
"	1913	"	96 "	"	1.45 × " "	1912;
"	1914	"	165 "	"	1.71 × " "	1913;
"	1915	"	250 "	"	1.51 × " "	1914.

Average for five years, 2.26 × the infestation of the previous year.

The year 1915 had an infestation 13.8 times that of 1910 but this high rate is very misleading in that the trees of 1910 were but 2.5 feet high and were rapidly becoming increasingly susceptible. Since the trees were so small Graham drew no conclusions other than the obvious "increase of the intensity of weevil infestation with height growth. . . . "[13]

No attempt to estimate the rate of increase of infestation for the Stony Brook tract was made in view of the virtually complete removal of parasites and the effect this would have had on the normal rate of increase. A comparison of the rates of increase before and after the removal of the parasites would have been illuminative but this was not feasible. The acceptance of the rates of new infestation given above should be regarded with caution since so many variables enter that are not considered in these figures. It suffices, probably, to conclude that there is a tendency for the weevil to increase each year unless artificial control, unfavorable weather, a rise in the number of parasites, or some other agency compensates. An intensive estimate beyond the scope of one individual and in several contrasted localities would be interesting but probably of little value unless a general formula could be derived. There are obvious difficulties attached to the evaluation of the variables which must be considered in the derivation of such an expression.

Description

The adult. The adult is an oblong, ovoid beetle ranging from 4 to 6.5 mm. in length, most of them nearer 6 mm., heavily chitinized and consequently hard to the touch; the entire body and legs are reddish light brown to darker brown in color; the elytra are marked more or less distinctly with areas of light yellowish

[13] It is only fair to mention that Barnes, in his unpublished thesis, utilized these data in much the same way.

and whitish scales on the posterior third near the median margins. The thorax, femora, and the venter may or may not possess other small patches of the whitish, cylindrically triangular scales, but the thorax usually has several small round spots, while single scales are scattered over the ventral aspect of the abdomen. The head is elongated to form the slender, cylindrical rostrum typical of the Curculionidae; it is as long as the thorax in the female and slightly shorter in the male; the antennae are inserted on each side very near the middle of the rostrum. The length of the head and thorax combined is slightly less than that of the wing covers; they are rather regularly and densely punctate; the elytra are covered with parallel striae which contain rows of pits that are larger and deeper than the thoracic punctations; the elytra are somewhat broader than the thorax at its widest point, with parallel sides for the anterior two thirds, converging to an apex posteriorly. The legs are strong, sub-equal, with tibiae that possess an incurved spine at the apex of each, with short, broad, four-segmented tarsi, and with simple tarsal claws.

The egg. The eggs range about .8 × .5 mm. in size,[14] are slightly to considerably oblong, equally rounded at both ends and, when first laid, are a pearly white in color and possess a certain degree of translucency.

The larva. The footless larva is a creamy white, often with a yellowish cast, and shows considerable variation in the proportion of thickness to length during its developmental period. A full grown larva is about 1.4 mm. thick and 7.5 to 8 mm. long, although many that pupate are smaller than this. The head, which is somewhat narrower than the body, is a conspicuous feature as it is hard, a light brown, and polished; the two small eye spots are black and distinctly visible; the ventral anterior of the head is a darker brown and the mouth parts are dark brown to black. The body appears divided by a number of convolutions in the epidermis, with bulges between the constrictions due to the large amount of subdermal fat; however, three thoracic and nine abdominal seg-

[14] One hundred eggs averaged .788 × .488 mm. Peirson (1922) gives the egg as measuring 1.5 mm., which is about twice the size of the eggs observed. Britton (1920) says that according to Felt (1915), the egg ". . . is globular, whitish, transparent, about one-sixteenth of an inch in diameter . . ." This is also about twice as large as the eggs seen, and they were not globular. For the sake of accuracy, the above number of eggs were measured. It may be noted that a fair degree of uniformity in size was found.

ments may be distinguished. The first thoracic and the abdominal segments, except the posterior one, bear a round, light brown spiracle on each side. Sparse, colorless hairs are distributed over the dorsal and pleural areas. A pulsating, somewhat darker, narrow area, lying anteriorly-posteriorly along the middle of the dorsum, indicates the position of the heart.

The pupa. The pupa, at first, is white to creamy; pigmentation occurs gradually, the eyes and mandibles first becoming brown, then black; the legs and snout "color up" next until, finally, the adult coloration is obtained. The grooves in the elytra are marked and a conspicuous feature is the pair of sharp, slightly curved spines which project from the ventral posterior of the abdomen. The length corresponds to that of the adult, or 4 to 6.5 mm.

Life Cycle

Pissodes strobi has but one generation a year and the greater part of its life cycle is spent in the adult condition. If, in general, the weevil lives several years as do some other members of the genus, and as originally suggested by Hopkins (1907) and discussed by Graham (1926), the adult stage is thus greatly prolonged. If the weevil is actively reproductive three, or even two, seasons, it is potentially a much more difficult pest to control than appreciated. No explicit data in regard to this point have yet been obtained.

The exact time of appearance in the spring, oviposition, egg-hatching, pupation, emergence, and the like, cannot be given a definite calendar date for the obvious reason that the weather varies considerably from year to year. Thus it might seem more accurate to correlate initial weevil activity with the development of common flora, as did Graham (1926),[15] but even this is unreliable. Barnes put the first weevil appearance when the mean temperature reaches 60° F. Since the time of first appearance varies from year to year with the advance of the flora in the spring, it is apparent that *Pissodes* responds more quickly to a rising temperature and is, moreover, less dependent upon rainfall than the flora. Thus some tem-

[15] Graham correlated the appearance of the first adults in 1915 at Ithaca, N. Y., with the flora when, "Of the deciduous trees only the cherries were beginning to put forth leaves . . . American elms had begun to set fruit . . . the shadbush and the aspens were in full bloom . . . (while) oaks and hickories showed scarcely any sign of activity."

perature scale may well be devised for the seasonal activities of the curculionid.

In the spring of 1927 at Stony Brook, the first weevils were noted ovipositing May 15, after the oaks were in full foliage; they were numerous one week later. The coolness of the first part of the month undoubtedly retarded the appearance of *Pissodes.* In 1928, same locality, the first weevils were seen April 7. This was before *any* of the deciduous trees were in bloom. The following excerpt of the daily temperatures, as recorded by the United States Weather Bureau at Boston, shows the effect of a warm period in advance of the usual gradual rise and agrees with Barnes' conclusion:

TABLE 2
Temperature for Early April, 1928, Boston, Mass.

Date	Maximum	Minimum	Mean
1	40	31	36
2	44	29	36
3	56	35	46
4	61	43	52
5	*84*	*42*	*63*
6	*82*	*52*	*67*
7	*76*	*54*	*65*
8	70	45	58
9	50	37	44

A colder period drove the weevils back into the surface litter and, except for sporadic appearances, they were not abundant on the shoots until May 3, when oviposition was first noted. It would seem quite probable that ovipostion in normal amount would have begun at the early April date if the warm period had been prolonged a few days more. A comparison of data taken with respect to the life cycle is tabulated (Table 3) for convenience.

There are several important features in the life cycle and these include the most surprising correlation between the length of the various phases and the climatic conditions, especially temperature, the lack of accuracy of calendar dates in predictions, and the spread of weevil activity, *e.g.,* oviposition occurring over a six weeks period is common (the extremes noted in 1928 were May 3 and July 11); it is the usual thing to find stages weeks apart in shoots from the same stand, and, commonly, even in the same shoot.

TABLE 3
Calendar of Pissodes Life Cycle

Stage	Ithaca, N. Y., '15 Graham (1926)	Conn., '19, Britton (1920)	Stony Brook, Mass., '27	Stony Brook, Mass., '28
First appearance	April 26	About May 1	May 15 (Probably May 12)	April 7
Oviposition	April 27–July 6	"A few days later"	May 15 to mid-June	May 3 to July 11
Hatching time	6 to 14 days, (May 3–11)[16]	6 to 10 days	10 days or more; May 25 on	About 19 days[17] May 22 on
Larvae start pupal cell	(June 3)	As a rule in less than two months	Majority by July 15	First case July 4; (probably July 1–3)
Larvae remain in pupal cell	14 days; pupae seen June 17		16 days; pupae seen August 1	About 10 to 14 days
Pupation period	"About 12 days"	"About 10 days"	About 14 days first adult August 9	About 12 days; first adult July 13
Adults emerge	Mid-July into October	Latter July into Sept.	Aug. 15 into September	See Table 4
Feeding period	"A short time"		A few days	A few days
Pre-hibernation	Not distinguished		Until the mean temperature drops below 60° F.	

The following table is based upon 335 weeviled leaders caged from July 11 to Sept. 22 (Table 4).

The time element has been emphasized since it is of vital import in regard to parasitism. Parasites more or less sensitive to thermal changes than *Pissodes* may fail to be at their proper stage of de-

[16] Parenthesis indicate that the date has been estimated.

[17] It is possible that other larvae in the eld hatched more quickly but it is indicated that the hatching period may be considerably prolonged by cool weather.

Table 4
Emergence of Adult Pissodes in 1928

Date	No.	Date	No.	Date	No.	Date	No.
July 31	1	Aug. 13	205	Aug. 26	96	Sept. 8	3
Aug. 1	0	14	190	27	50	9	7
2	2	15	170	28	40	10	0
3	2	16	150	29	28	11	4
4	6	17	185	30	37	12	7
5	8	18	175	31	16	13	7
6	12	19	310	Sept. 1	10	14	0
7	27	20	181	2	7	15	0
8	63	21	142	3	9	16	0
9	72	22	176	4	13	17	2
10	120	23	101	5	6		
11	168	24	102	6	1		
12	175	25	104	7	4		

velopment to oviposit when the weevil is in an optimum stage for parasitization. Thus it was found in the spring of 1927 that, under natural conditions, either the parasites appeared too early, or the weevils too late, for a maximum of parasitism to occur. The warm days of late April in that year brought out some of the parasites before their host had appeared, or considerably in advance of weevil oviposition and the production of larvae large enough to be parasitized. It is evident that, under natural conditions, some of the parasites are able to survive a waiting period, or they find other acceptable hosts, but, under laboratory conditions, parasites not kept at an artificially lower temperature may not live until the time for parasitization is at hand. This single factor, then, may negate the possibilities of success in the manipulation of parasitic forms in the laboratory. On the other hand, if the parasites come out a little later than "normal" they may find no hosts among *Pissodes;* in fact, it appears that the summer emergents in most cases are not able to parasitize the weevil because the susceptible period of the latter has passed.

Habits

The possible dissemination of the adult weevil in the spring by flight is of considerable economic importance. It was not shown until recently whether Pissodes could fly. Peirson (1922) assumed that the weevils flew and says that the "Evidence all points to the fact that the beetles usually fly over the plantations before egg laying.'' Graham (1926) made a solitary observation: ''This one occasion was in mid-afternoon of a warm day in the early spring of 1916. On that day many weevils were flying. They were strong fliers. . . . This unusual occurrence suggests the possibility of a short period of flight during early spring, whereby the weevil becomes widely disseminated, followed by a period when it seldom if ever takes wing.'' MacAloney (1926) has noted weevil flights and Barnes obtained some interesting data on the types of weevil flight, the conditions for the same, and the like; and he was able to keep in sight an individual weevil for about one hundred yards, which, when lost to view, was still on the wing and flying strongly. The question of distance flights is still unsettled.

Whether by technical flight, or by the carrying power of the wind,[18] there are indications, however, that the weevil is able to infest new territory at appreciable distances from the area of origin:

1. Specimens of *Pissodes approximatus* Hopk. have been taken in the ''wash-up''[19] in early June near Nahant, Mass., by P. J. Darlington, Jr. It seems reasonable that the closely related *P. strobi* might be obtained in a similar situation and the time of collection corresponds to the general oviposition period of the genus.

2. An interesting note with a bearing upon the subject was related by Mr. James Morris of the Massachusetts State Forester's Office. It appears that an open field, a former nursery, at East Sandwich, Cape Cod, Mass., was planted to white, red, and Scotch pine, while a few intermingled hardwoods were allowed to remain. This tract was free from weevils until 1921 and the trees, which ranged from four to nine years in age, had been growing vigorously. In this year, however, in the one season, a very heavy infestation of *Pissodes* developed. Since the plantation was at least 18 miles from the nearest white pine, according to the Forester's Office rec-

[18] Barnes states that while the weevils do not initiate flight in a strong wind, they take off into a slight breeze and then turn and fly with it. It is not incredible that a freshening wind might make the flying weevils ''involuntary'' colonists in new tracts at some distance from the starting point.

[19] The ''wash-up'' refers to the flotsam and jetsam, including the bodies of insects, thrown upon the beach by the waves. Insects, which have been taken out to sea by an offshore wind while on the wing and which have eventually fallen into the water, are thus made accessible to collectors.

ords, and the Cape Cod canal intervened, and with a consideration that such a heavy infestation in one season would very probably not occur through accidental agencies of any other nature, the inference seems reasonable that a relatively large number of the beetles flew or were blown to the locality. The weevil may have been present in the pitch pine (*Pinus rigida*) so abundant on Cape Cod, but with the suddenness and severity of the attack, this explanation would not seem quite sufficient.

It would seem that, since *Pissodes* does fly, the possibility that winds may take it long distances is always present. It must further be borne in mind that, while it is a relatively heavy weevil, the insect has the thoracic musculature of a strong flier. After a consideration of all such evidence which has been mentioned, it seems probable that Graham was correct when he presented the contingency that the weevil may become widely disseminated prior to, or during, oviposition.

When the adults have attained the top of the leader in one of the ways mentioned previously, they feed on the meristematic tissue beneath the tender bark at the tip and upon the terminal bud cluster for a day or two. Males and females *in copula* for hours at a time during the feeding period are common and may be observed readily. After mating, the females oviposit progressively down the shoot while the males are found more or less nearby during the entire oviposition period. Most of the eggs are laid near the extreme tip of the leader, from the terminal bud cluster to a foot below, but punctures which contain eggs may be found a yard below the tip. Weevils which reach the leaders several weeks after the first heavy oviposition has occurred, usually begin their progressive downward oviposition in advance of, or below, the other eggs or hatched larvae.

It is difficult to distinguish between punctures which contain eggs and lesions made by feeding since they are made in the same manner and are the same size. It is only by dissection of the leader or by a close watch of the acts of the female that a determination of which punctures contain eggs can be made. A small number of shoots taken at random at the height of the oviposition period, yielded an average of 11 feeding holes in the bud cluster, 43 feeding punctures in the leader, and 40 other punctures which contained 61 eggs. This agrees with MacAloney's (1926) finding that "Roughly . . . 75 per cent of the punctures contained eggs."

After a cavity is made with the mandibles, the female moves over the puncture so as too place the tip of her abdomen above it.

One, two, or three eggs are placed within the cavity, which is slightly larger than the contents. The complete process of excavation and oviposition requires at least 30 minutes and may extend over one hour. MacAloney (1926) says that the females each lay from 50 to 150 eggs, which are usually distributed between several leaders. Several females simultaneously ovipositing on the same leader is very common. MacAloney reports an average of about 125 eggs per shoot.

In the process of development, the uniformly pearly white egg changes so that the middle portion is yellowish or cream while the ends appear to be filled with a hyaline liquid. When the eggs hatch, the first instar larvae at once begin the consumption of the succulent tissues which surround them. The heads of these larvae have no pigmentation and are soft; internally, an amorphous yellow mass, reminiscent of the yellow band in the developing egg, is present.

An interesting point is whether these larvae of *Pissodes* are positively geotropic. Some of the larvae mine upward but the large majority mine downward; except in rare instances, those which do not mine downward fail to survive because of lack of food. It is believed that the weevil larvae are not positively geotropic, at least to any appreciable degree. This belief is based on the following grounds: (1) The direction of the first mines indicates that the larvae begin to feed in the directions they are pointed when they hatch. They mine laterally, in circles, or upward, apparently, as readily as downward at first and, if the competition is not too severe, such a course is not invariably disastrous for a pupal cell at, or near, the extreme tip of the leader has occasionally been found. Usually after a short time, however, when the pine tissues are less moist and the food at the tip more or less consumed, the larvae, apparently by "trial and error", find that the food is better and more abundant below the area of initial feeding. As more and more of the grubs take this direction, the alternative of eating downward becomes more and more necessary if starvation is to be avoided; subsequently hatching larvae must mine downward at once or starve. (2) Thus, the presence or absence of, and the quality of, the food supply may be assumed, reasonably, to be at least one factor in the direction taken by the larvae. (3) Barnes inverted weeviled leaders and found that the larvae mined both upward and downward (4) Leaders kept in a horizontal position, incidentally in this study, have shown that the larvae, in general, continued to mine into the edible tissue or towards the thicker end. (5) What might seem alone a decisive answer to this question is the behavior of the weevil larvae when they are crowded at a whorl. In such instances the larvae enter the laterals and mine outward and upward. These findings combined would seem to indicate an independence of positive geotropism, or, at least, its being of secondary importance in the behavior of the weevil larvae.

The larvae feed voraciously and, according to Peirson (1922), digest their food in approximately one hour. Within a few days after hatching the typical weevil "ring" is formed. It is clear that, if the ring is incomplete, the larvae are often drowned in the profusion of exuding pitch but, if their numbers are sufficient to make a complete circle, the tissues are apparently consumed so rapidly that the output of pitch is much reduced. In this ring[20] the larvae form one or more ranks with their bodies in virtually uninterrupted contact all the way around the leader. Behind the front ranks there may be several less regular and complete ranks, composed of fewer larvae, and behind these, stragglers are numerous. Competition for food is very intense and the rear rows, and especially the stragglers, find very little to eat unless they are able to enter the front row. Most of the larvae, which are unable to catch up, and those hatching behind the ring, starve to death; indeed, it is estimated that 80 to 90 per cent of the immature larvae in the "average" leader starve to death. Under these conditions cannibalism, as originally noted by Hopkins (1907), occurs. To find the mandibles and head of a larva embedded in the partly consumed body of another is not rare.[12] Since the victims of this intraspecific destruction were doomed to starvation in any case, this cannibalistic habit is of no economic importance. It will also be shown, later, that the value of a parasite is lessened to the extent that it feeds upon these fore-doomed, partly grown larvae.

The rate of weevil advance down the leader has been measured in the field by the simple method of sticking pins in the shoots at the frontiers of weevil progress and by making daily measurements from pin to pin. These readings were made at the time when most of the

[20] One factor which is responsible for the formation of the ring is that the progressive downward oviposition of the adult insures that the first-hatched larvae move into zones of later oviposition at about the time these eggs hatch and the ring is thus augmented as it progresses down the shoot.

[21] Many lethal injuries, which are unattended by any nutritive benefit, are also, inflicted upon one another by these larvae left marooned in groups in the frass.

larvae were about two weeks under maturity and the rate derived probably represents one close to the maximum. It may, of course, be assumed that when the larvae are younger and smaller their rate of advance will be less. It will be noted that a delay occurs in passing a whorl; often a lateral is chosen in preference to continuing through the tougher tissue of the node. With a figure for the average maximum rate of advance and one for the average duration of larval feeding, it becomes possible to make a rough estimate of the probable average distance a series of given leaders will be destroyed. When this done it will very probably be found that white pines in

TABLE 5

The Rate of Descent of the Leader by the Weevil Ring

No. of tree	7/10	7/11	7/12	7/13	7/14	7/15	7/16	Average per shoot in centimeters
1	3.1	1.5	2.7	2.3	0.0	0.0	3.1	1.81*
2	.3	1.1	3.1	0.0	0.0	0.0	1.5	.85
3	1.3	1.8	2.6	4.1	0.0	0.0	2.4	1.74
4	1.5	1.3	1.6	1.3	0.0	0.0	3.2	1.27
5	1.3	1.6	1.3	1.4	0.6	1.8	1.5	1.35*
6	1.8	1.6	0.0	0.1	0.4	3.6	2.6	1.44
7[22]	1.8	0.0	0.4	0.0	0.0	0.0	0.0	(.31)
8	0.0	0.5	0.0	0.0	0.0	3.1	0.9	.64
9	1.3	3.5	1.3	0.6	0.5	1.5	0.5	1.31
10	0.0	0.0	0.0	3.5	1.1	1.0	0.9	.93
11	2.5	2.3	2.2	4.9	4.4	0.8	2.9	2.85
12	2.1	1.9	2.7	2.4	1.6	0.0	3.4	2.01
13	1.9	4.2	3.0	1.4	0.0	5.4	3.5	2.77*
14	1.6	1.8	2.8	2.1	0.8	2.2	1.6	1.84*
15	2.6	1.0	2.9	0.9	2.4	2.5	2.1	2.05*
16	2.8	1.9	0.8	2.4	0.2	1.9	1.6	1.65
17	0.7	1.5	1.2	2.2	0.8	1.2	1.3	1.27*
18	1.8	1.5	0.0	3.4	3.7	2.9	2.3	2.23*
19	0.9	1.3	2.3	0.3	0.0	2.0	0.0	.97*
20	1.7	2.6	2.0	1.6	0.6	1.7	2.7	1.87
Average per day	1.6	1.6	1.7	1.8	.9	1.7	2.0	1.64 Average per shoot per day.

* Tree was grown in more open expanse.
0.0 underlined indicates a whorl or node.

[22] All the larvae in this shoot proved to be pitch-drowned; this shoot was not averaged in the final figure of 1.64 cm.

favorable localities those which have long leaders, may be expected to be unweeviled below the first whorl.

As the larvae mature they fall out of line, burrow into the xylem, form their pupal cells, and become quiescent. Because of the differential time of maturity, the leader thus has pupal burrows scattered along its length, though the majority of cells will be increasingly concentrated until the limit of advance is reached. Due to later oviposition, a ring of larvae may continue to mine a considerable distance below where the majority of the earlier ring is pupating; this is common in heavy infestations. The burrow lowermost in the shoot usually does not represent the farthest advance, for it is very likely to be so filled with pitch that the larva or pupa within it is drowned. Upon the dissolution of the ring formation, the last few larvae, however large and vigorous, are thus placed at a distinct disadvantage. If too many larvae are present at one point, deeper burrows are made into the wood and, if the necessity arises, galleries are constructed in the harder tissue of the whorl. Often many cells are found at the bases of the lateral shoots, and burrows for several inches within the laterals themselves are by no means uncommon. One top from a heavily infested tree taken at random showed 14, 8, 5, and 2 pupal cells in four of the larger laterals at the first whorl.

The weevil larva becomes motionless after its pupal cell is formed, while the changes of pupation take place. The contents of the body become more fluid and the thoracic region swells. The mandibles remain closed and apparently cannot be moved, though the power of abdominal writhing upon stimulation is not lost. After a gradual continuation of the processes of internal reorganization, the thorax, its appendages, and the abdomen become more differentiated. The hardened head shell is sloughed off and the pupal head appears, completely formed.

In virtually every case, the pupal cells are so constructed that the larva or pupa lies parallel with the longitudinal axis of the leader and, after the larva has turned its ventral portion toward the nearer surface of the shoot, the head faces the entrance gallery which was entered. The head is thus toward the apical end of the shoot, in contrast with the head-down position of the feeding larva, and the adult, when formed, is in the only possible position for successful emergence. Only more or less wadded wood chips and a dry, paper-thin bark intervene between the outer air and the pupal cell, and often this latter barrier is removed by birds; yet despite this seemingly easy means of egress, about four per cent of the weevils become stuck and perish.

It has been considered desirable to separate the pupal cells into three arbitrary classes for greater convenience in discussion in connection with parasitism. This classification is based upon their position in the leader.

Type One: Cells in the pith and primary xylem, with galleries descending from the periphery generally at a sharp angle; in slender leaders, one-fourth to three-eighths of an inch in diameter, the cells are almost invariably of this type; in thicker shoots, the entrance shafts may be vertical. Under these conditions parasitism by *Eurytoma pissodis* Gir. most often occurs and the degree of parasitization in individual leaders may be as high as 100 per cent.

Type Two: Cells entirely in the xylem, nearer the surface than those of Type One, with entrance galleries often descending at less sharp an angle; the long axis of the cell may be considerably off from parallel with that of the leader; more common in leaders thicker than three-eighths of an inch and is the most common type of all since the average leader is thicker than three-eighths of an inch. In this situation parasitism by *Microbracon pini* Mues. and other braconids is common.

Type Three: Cells essentially shallow depressions in the peripheral xylem, roofed with wood fibers, and immediately under the bark. This type of cell is distinctive and similar to the "chip cocoons" (Packard, 1890) characteristic of the more primitive members of the genus *Pissodes.* It has been impossible to determine if cells of this type are constructed by feebler larvae or under the stimulus given by the crowded condition of the leader. In either event, this type of cell is most accessible to parasites and birds. Under these conditions large numbers of weevils are destroyed, especially by the parasitic fly, *Lonchaea corticis* Taylor.

All pupal cells are apparently just large enough to hold a pupa after both ends and the entrance shafts have been wadded with masses of shredded wood, the result of excavation. The pupal cells are never lined with any material.

The weevil larva occupies its cell about 10 to 16 days in order to become a pupa, and the pupation period itself requires about two weeks more. During this period the pupal development and gradual pigmentation occur in relative security if parasitism has not taken place previously. The adults remain in the pupal cell from one week to one month, usually about two weeks, before they emerge. The cause of this delay is somewhat obscure. The final pigmentation of the adult requires but a few days. Since the entrance shaft of a cell is more or less plugged with wood fibers, and it is clear that when the entrance is well blocked the adult cannot emerge, it is probable that much of this time is required to remove the obstructing débris; nevertheless, the time consumed before emergence seems somewhat excessive for this task alone.

After the adults have emerged through neat, circular holes in the bark, about 2.5 to 3 mm. in diameter, they feed upon the needles and bark of the laterals and main stem for several days to a week until their feeding decreases in vigor and they become torpid. Apparently the temperature usually prevailing in August induces this quiescent state or aestivation. The weevils cling to the bark or remain motionless in crevices and are not readily observed at this time. When cold weather begins the weevils seek the pine litter and lapse into the true torpor of hibernation. Barnes has found that they never penetrate the ground proper but in cold weather work down to it; they are essentially a winter-hardy insect, though more or less are doubtless winter-killed, especially by alternate thaws and freezes.

The possibility of fall mating has been discussed by Graham (1926) and others. Though occasional weevils may simulate copulation, actual insemination at this time seems doubtful, while fertilization in the fall, as stated by Hopkins (1907) and corroborated by Barnes, is impossible; though sperm may be ripe, the ovaries of the females are entirely too undeveloped to produce eggs. If some of the weevils live several years, oviposition in the fall by old females is a theoretical possibility but very probably does not occur. According to Barnes, fall flights may occur if the temperature is favorable and it follows, therefore, that a spread of Pissodes into new territory may take place at this time.

Control

The white pine weevil is difficult to control and, indeed, no thoroughly satisfactory treatment, whether for ornamentals where expense is secondary, or for large areas where direct control may not be justified, has yet been devised. Numerous control experiments have been made by different investigators and many constructive recommendations have been derived from these, but the problem is still open to a complete solution. This paper will summarize the findings of those who have experimented with control.

It is clear that of all research done, though parasites have been held to be valuable, no one has attempted to measure their effectiveness.

Hopkins (1907) estimated that from presumably all natural causes, not more than three to five per cent of the hatched larvae reach maturity. How these figures are obtained is, unfortunately, not given. A count of the exit holes, pupal cells, and the like, in a sample of 3,009 weeviled leaders dissected in the course of this study, showed that 17,713 or about 50 per cent of the *mature* larvae successfully emerge as adults (and the mature larvae are only about 10 to 20 per cent of the average of 100 to 125 eggs laid per leader) or 5 to 10 per cent of the weevil eggs. If only half of the emerged adults survive the thaws and freezes, small ground mammals, and birds in the spring, then the percentage of eggs of one year represented by mating forms the following spring is from about 2.5 to 5 per cent, which is virtually identical with Hopkins' estimate.

It would seem, with its very large natural mortality, that the weevil might be substantially reduced by the addition of artificial measures of control but such is not the case. The margin of safety in overproduction is so considerable that even partial control is difficult. It should be recalled that one fertilized female may lay well over 100 eggs and that only four or five partly developed weevil larvae are sufficient to kill a leader.

Control of the weevil may be grouped under the following headings and sub-headings:

A. *Natural control*, in rough chronological order.
   1. Failure of eggs to hatch.
   2. Starvation of larvae due to
      a. Mining in the wrong direction.
      b. Lack of food because of competition.
   3. Drowning of larvae and pupae in pitch.
   4. Larvae preyed upon by clerids and *Dioryctria* larvae.
   5. Larvae and pupae preyed upon by birds.
   6. Larvae and pupae parasitized by flies and parasitic Hymenoptera.
   7. Larvae and pupae destroyed by bacteria and fungi (?)
   8. Adults stuck in the leaders.
   9. Adults eaten by ground mammals.
   10. Adults eaten by ground birds.
   11. Adults winter-killed.
   12. Adults eaten by birds in the spring.

B. *Artificial control.*
1. Mechanical methods.
    a. collection, chiefly by jarring.
    b. *traps.
    c. banding.
    d. *bagging.
    e. pruning.
2. Chemical methods.
    a. sprays and washes.
    b. *dusts.
    c. *gas.
    d. *baits.
    e. repellents.
3. *Thermal methods.
4. Silvicultural methods.
    a. Shading, accomplished by
        1. Mixed species of pine.
        2. Mixed pines and hardwoods.
        3. Dense plantations of pure pine.
5. *Biological methods.
    a. Introduction of parasites.
    a. Introduction of insect predators.
    c. Introduction of predatory birds.
    d. Introduction of pathogenic organisms.

Methods of control will be discussed briefly in the order given. Those headings which are marked by an asterisk are omitted from discussion as methods not at all feasible or never tried.

A. *Natural control.* (1) Usually almost all of the eggs laid in the leaders hatch, however, as also noted by Barnes, eggs that do not hatch before or shortly after the weevil ring has been formed fail to do so, very probably because the shoot is then too dry.

(2) If the newly-hatched larvae are in a region of frass, as is often the case, they will starve; a similar fate is the lot of the minority that mine in a direction where food is scarce. All the larvae in the ring itself are not destined to survive because of the limitations in the food supply. As has been stated, about 10 to 20 per cent of the first instar larvae find sufficient food to reach larval maturity; the others, on the whole, starve to death.

(3) Those larvae and pupae which have constructed or occupy cells below where the majority of the members of the ring have done so, are liable to death from the pitch put forth by the tissues of the leader. In 3,009 weeviled shoots, 882, or about 2.5 per cent of the mature larvae and pupae were so drowned.

(4) A comparatively large number of insects, in their larval stage, undoubtedly prey upon the weevil grubs. Chief among the insect predators are the larvae of clerid beetles and the summer caterpillars of a new species of *Dioryctria.* Packard (1890) and Riley (1885) state that "the young of Tenebrionidae" are very commonly predacious upon Pissodes larvae but no investigators have substantiated this. A list of insects of unknown, of doubtful, and of no connection with the weevil but resident in coniferous leaders concurrently with, and subsequently to, the stages of Pissodes, has been published (Taylor, 1928); of these there are probably a number of species which occasionally consume weevil larvae upon encounter. The several predators which apparently seek out the grubs and which are more numerous will be discussed in Section B II.

(5) Birds are of great importance in reducing the numbers of Pissodes. It is common to find weeviled leaders, which have been stripped at the optimum time, almost entirely free of the insect. Indeed, if the bird population were greater, so that more of the leaders were cleaned, it is probable that the weevil would be noticeably checked. The observations of Graham (1926) and MacAloney (1926) give the credit to such birds as the nuthatches, the chickadees, and certain woodpeckers. Graham also points out that the adult weevils are exposed to ground feeders. MacAloney has stated that "Through protection of insectivorous birds . . . we may get a greater degree of control than by any other biological method." This author found that ". . . nearly 30 per cent of the leaders were stripped by birds and the larvae eaten" in one plantation. In the course of this study, data were obtained incidentally while making other counts, and these will be given for comparison. In the sample of 3,009 leaders dissected, all shoots, where the bark was torn in a manner characteristic of birds, were examined carefully and all incomplete pupal cells of Type Three, where there was no positive evidence of parasitism, were ascribed to birds. While subject to error in such determination, the figures obtained are believed to be close approximations of the bird effectiveness in the material studied. Only well grown and mature larvae are dealt with in this table but field observations have shown that, apparently, it is not until the larvae are fair-sized that the birds become aware of this source of food.

In cases in the above table where the percentage of effectiveness in some of the states other than Massachusetts is low, it is probable

TABLE 6

The Effectiveness of Birds in the Control of Pissodes strobi

Source	Total no. shoots	No. shoots attacked	Per cent shoots attacked	Larvae consumed	Total no. larvae in attacked shoots	Total no. larvae in all shoots	Per cent of average thoroughness in attacked shoots	Per cent of average effectiveness in all shoots
Sidney, Me.	42	16	38.09	55	196	353	28.06	15.68
Oneonta, N. Y.	35	16	45.71	76	325	568	23.38	13.38
E. Greenwich, R. I.	15	7	46.67	20	62	152	32.35	13.15
McConnellsburg, Pa.	7	2	28.57	6	24	47	25.00	12.76
China, Me.	32	16	50.00	79	224	381	35.26	20.73
Ansonia, Pa.	9	1	11.11	1	10	74	10.00	1.35
Readfield, Me.	24	18	75.00	83	268	341	23.50	24.34
Sizerville, Pa.	22	8	36.36	24	99	210	24.24	11.43
Concord, N. H.	15	8	53.33	50	175	215	28.57	23.25
Durham, N. H.	37	6	16.21	16	101	645	15.84	2.48
"Northwest" Conn.	13	7	53.84	20	53	69	37.73	28.99
Milroy, Pa.	14	4	28.57	15	53	167	28.30	8.99
Bradford, Vt.	32	23	71.87	127	320	431	39.68	29.46
Mentor, O.	29	12	41.37	41	106	214	38.67	19.15
Mont Alto, Pa.	12	8	66.67	75	161	174	46.58	43.10
Fayetteville, Pa.	23	11	47.82	75	145	213	51.72	35.21
Roscommon, Mich.	26	6	23.07	30	97	237	30.92	12.65
Ann Arbor, Mich.	13	3	23.07	5	24	65	20.83	7.69
Blain, Pa.	7	1	14.28	3	12	29	25.00	10.34
Total of other states	407	173	42.50	801	2455	4585	32.62	17.47
Mass.	2602	974	37.43	5534	19787	31351	27.96	17.65
Grand total	3009	1147	38.11	6335	22242	35936	28.48	17.62

that intact shoots, relatively unriddled by birds were selected. On the whole, the data for the total other-state material are remarkably consistent with the data for Massachusetts. These findings may be interpreted to mean that control by birds in 1927 was fairly uniform over the areas specified. While, unfortunately, the birds consume the parasites also, not only in the summer but all winter long, it is nevertheless clear that birds are important and one of the chief biological factors in the natural control of Pissodes.

(6) All parasites are treated in Section B II.

(7) Under natural conditions, very few weevil larvae or pupae covered with fungous mycelia were noted and, in the occasional case so noted, it was impossible to say definitely that the fungus was the cause of death. Species of the genera *Aspergillus* and *Penicillium,* which were common in cultures, are not usually regarded as entomophagous. Bacteria are much more prevalent in the leaders. Full-sized larvae turning black in the stages of decomposition are fairly common in the shoots but in such cases it would be difficult, indeed, to ascribe the cause of death definitely to bacteria, though the starvation factor might seem eliminated by the maturity of the individuals. It would seem probable that pathogenic microorganisms are responsible for some of the mortality of the weevil larvae but are probably not an important agent of control under the usual conditions that prevail in the leaders.

(8) As previously discussed, when the entrance shaft to the pupal cell is tightly plugged with the wood fibers left from excavation, an adult may be unable to emerge. In the 3009 leaders dissected, 1402 adults, or nearly four per cent of the mature larvae, were found stuck and dead of starvation. If the percentage of stuck adults is based upon the number of weevils which actually attain the adult stage, then between seven and eight per cent of the adults fail to emerge from this single cause.

(9) Graham (1926) believes it likely that such small mammals as the shrews and wood mice may consume some of the hibernating weevils. While the former are insectivorous and the latter partly so, it would not seem that they can be considered as a factor of much importance in this instance since the adult weevils hibernate exclusively in the dense needle layer of the forest floor, where they would seem less accessible than the miscellany of larvae and pupae to be found in the soil.

(10) There are no data available on the extent to which aestivating or hibernating weevil adults may be eaten by ground birds but Graham (1926) mentions an instance where ". . . the white-

pine weevil has been at least partially checked by allowing chickens to run in the plantation.'' Graham points out that the weevils are exposed to such birds as the chewinks, the thrashers, grouse, and quail. It seems quite probable that the ground birds are considerably less important than those which explore the leaders, since the adult weevils, because of protective coloration, are rather inconspicuous at all times that they are not hidden in the needle layer.

(11) The extent to which hibernating weevils are winter-killed very probably depends more upon the number of thaws and freezes, and sudden contrasts of temperature, than the lowest temperature reached during the season, though, of course, there is doubtless a lethal minimum. Weevils kept in covered tin boxes filled with pine needles and left outside over winter were all winter-killed. That the average of about six weevils which emerge per shoot do not all survive, is clear, in that, while Pissodes infestation tends to increase from year to year, the weevil does not triple its numbers yearly. If it be estimated that perhaps half of the hibernating weevils are killed over winter, then it may be assumed that much of this mortality is due to rapid and lethal fluctuations in temperature.

(12) In the spring during feeding, copulation, and oviposition, Pissodes is well exposed to bird attack. Though no birds have ever been observed preying upon the weevil at such a time, theoretically, to some extent, the adults may be eaten.

B. *Artificial control.* (1a) Felt's (1913) method of collecting weevils by jarring requires a net, about 15 inches in diameter, to be held close to the leader on one side while a sharp rap with a stick is applied on the other side. This is a simple and fairly effective method on small tracts where the expense of $2.00 per acre (as estimated by Britton in 1920) for six collections is not considered excessive. On large tracts, especially where the terrain is difficult, the expense of this method would be prohibitive. A serious disadvantage of this method is the obvious fact that all weevils cannot be prevented from oviposition by collections made at intervals of one week; moreover, as pointed out by Graham (1926), some adults wedged in the terminal bud clusters will not be dislodged; others will miss the collection net, fall to the ground, and subsequently attain the leaders again. Finally, the carefulness and intelligence of the labor are often critical factors in the application of collection methods to ornamental pines where expense is a secondary consideration. In a light infestation, Walden (1915) reduced weevil injury about 50 per cent by the collection of weevils by jarring.[23]

(1c) Banding with tanglefoot or some similar substance is more or less effective, particularly if the band is placed high on the young tree, or better still, if there are two bands, one at the base and one below the leader. Weevils on the wing may still reach the leader but MacAloney (1926) found that a single band at the leader was "very effective." Banding methods are applicable to ornamentals only, since they are much too costly for large tracts. If cold rainy weather glazes the bands, the sticky substance should be replaced.

(1e) Pruning the infested leaders, as originally suggested by Hopkins (1907), is recommended or described by nearly every writer on the subject of the control of Pissodes; it is the most commonly used direct method. It consists, essentially, of culling the infested shoots before any of the adult weevils have emerged. At least two collections are desirable in order to prune those missed at, and those infested since, the earlier collection. The culled shoots may be burned, though, since the parasites are destroyed in this way, it is usually recommended (also originally by Hopkins) that they be confined in screened containers which are then left in the tract for one year. Theoretically, the mesh of the screen must be too small to allow the weevil to emerge, yet still large enough to permit the egress of the parasites. MacAloney (1926) found that "12 or 14 mesh wire is the best suited for this purpose." He says, "A few of the very smallest weevils may emerge through this 12 mesh, but if 16 mesh is used as has heretofore been advised, only the smaller parasites can get through. . . . " The more important forms, as MacAloney suggests, could not pass through such a mesh at all. Preferably, the receptacles should be screened at both ends and placed on their unscreened sides to avoid the collection of water and the destruction of the parasites. All crevices in the containers must be made tight. In general, this method must prevent the weevils from reaching the trees the following spring, as they most certainly will be able to do if the pruned leaders are left lying on the ground. This method, in theory, gives complete control; actually, it is reasonably effective if the following factors are operative:

1. A repetition of this method every year, or as long as weeviled leaders are observed.

[23] Net used— 8.9 per cent infestation;
Check —18.9 per cent infestation.

2. The thoroughness with which all infested leaders are culled. (The leader should be cut, of course, below the furthest weevil advance and below any late oviposition punctures which may be below the frontier of weevil activity.)

3. The removal of the leaders at the correct time, which is after the *last* oviposition and before the *first* weevil emergence. Early pruning may save part of the tree that would otherwise be destroyed if the cut can be made above a whorl rather than below it.

4. The preservation of the parasites.

The contents of the receptacles may be burned in July of the year following confinement after the last parasites are out; all weevils confined within will have been winter-killed or starved.

An important mitigating consideration in regard to this method is that, while the weevils are reduced, they are never exterminated as should be the case, theoretically. This may be due to lack of thoroughness or to reinfestation from nearby infested areas. Successful control by this method would include a similar treatment of all adjacent foci of infestation. In adition, there is always the possibility of reinfestation from distant tracts by weevil flight and the carrying power of the wind. Since perpetual freedom from weeviling is thus more or less precluded, continued measures must be employed until the pines reach the degree of growth that brings immunity.

MacAloney gives the cost of pruning at twenty-five cents to $2.00 an acre per year. The receptacles are too expensive for large tracts. Because of the high cost and the virtually unavoidable reinfestation, it is very probable that pruning is not justified in a great many cases.

If the infested trees are pruned, it has been recommended to prune also all but one of the laterals of the topmost unweeviled whorl, so that in time this selected lateral, as it takes the growth, will materially, perhaps entirely, reduce the crook of the future log. MacAloney (1926) modifies this with the valuable suggestion that only the terminal bud clusters of all but one lateral be removed. He states that "This seems to result in the remaining lateral absorbing all the available nutrient materials which would have gone to the other laterals as well as the amount it would have normally used itself. Removing the bud clusters does not impair the growth efficiency as much as if the entire length of each lateral was removed. That is, the amount of leaf surface is not reduced as would be the case if the entire lateral was removed. The laterals so treated do not grow appreciably and there is no wound at their bases. . . . ''

(2) Various sprays and washes have been tried for the control of Pissodes. Graham (1926), after a series of tests, concluded that ''It is doubtful whether the chemical method of applying sprays and washes will prove sufficiently effective in controlling this pest to make its use economically practical.'' After experiments with a number of substances, Graham found that a spray of either pure carbolineum or pure creosote gave good results but he adds that ''Sprays and washes . . . have not proved sufficiently effective to warrant their use.'' Britton (1920) found that the common 1:8 mixture of commercial lime-sulphur and water applied when only the old leaves were present, was a repellent of about 50 per cent effectiveness. MacAloney (1926) also tried lime-sulphur and obtained similar results and noted that infestation of treated leaders occurred, in a majority of cases, after the substance had been washed off by rain. For large tracts, chemical methods are too expensive and, in the case of ornamentals, it should be remembered, as MacAloney points out, that much of the material is wasted in its application to the only part of the tree, the slender leader, that requires the spray.

(4) Of the possible methods of control of the white pine weevil in large plantings of white pine, the forest entomologists, who have been engaged with the problem, have appreciated that silvicultural practices and forest management are the most suitable methods to employ under such conditions. These methods of control, for example, have been the primary concern of Peirson's, Graham's, and MacAloney's researches. In each case, the suggested control has been based upon the effect of shade upon the positively phototropic weevil. With silvicultural methods and forest management, shading may be obtained by:

a. Mixed species of pines.
b. Mixed pine and hardwoods, or hemlock.
c. Pure pine in dense stands.

(a) In regard to the location of a new plantation, Blackman and Ellis (1916) state: ''If . . . the pines in a radius of several miles show no signs of the work of the pine weevil . . . white pine may be planted with a fair chance of escaping serious damage provided the plantation is systematically inspected and thorough measures taken when any evidence of the work of the insect is found.'' This statement is necessarily a qualified one and implies the possibility that Pissodes may fly or be blown into the tract.

These authors found, in a plantation near Fulton, N. Y., that white pine in alternate rows with Scotch pine escaped injury. It was concluded that initially the faster growth of the latter, with the consequent shading of the white pine, was probably the chief protective factor. Belyea (1923) reported that, in certain plots where the weevil infestation in pure white pine was 73.4 per cent, the adjacent Scotch pines were infested 20 to 25 per cent, and that, in case where the two species were mixed, the percentage of infestation rose for *Pinus sylvestris* and dropped for *P. strobus*. Belyea believed he had found a reduction of white pine infestation of about 40 per cent and concluded therefrom that Scotch pine may well be employed as a trap tree to save the white pine. Subsequently, however, this author (Belyea and MacAloney, 1926) retracted this conclusion because he found that a pathological condition, probably frost, was responsible for the greater part of the observed Scotch pine injury. It was then concluded that Scotch pine is protective against Pissodes, not as a trap tree but as a mechanical barrier which forces the insect to fly higher. The marked susceptibility of *Pinus sylvestris* to frost injury was emphasized.

Peirson (1922) says "Scotch pine has been suggested, but the benefit gained would hardly be offset by the loss of space taken up by the Scotch pine, which hardly seems worth planting as long as better trees are available. Furthermore, the cost of planting the Scotch pine could in no case equalize the benefit gained." From all the foregoing, it would seem that the value of Scotch pine in avoiding Pissodes infestation needs further study. At North Beverly, Mass., Scotch pines adjacent to infested white pines were also infested, though to a lesser degree.

(b) Mixed pine and hardwoods, or hemlock, as suggested by Peirson (1922), Graham (1926), and MacAloney (1926), seems a sound practice for several reasons: (1) The shade obtained for the pine is denser; (2) the broad-leaved foliage acts as a mechanical barrier against weevil flight; (3) the soil is undoubtedly kept in better condition in mixed stands. It has long been noted that, in general, young pines in natural mixed stands have a certain degree of immunity. Graham's analysis of this is given:

"Weevil injury is invariably greatest in open pure stands of white pine growing in full sunlight. In mixed stands where hardwoods shade the pine, the injury is much less, and it decreases with increasing intensity of shade until it reaches the zero point under a shade such as that cast by an average stand of oak or maple.

"In view of these facts, which have been proved beyond a doubt, it would seem that some system of silviculture should be used which would provide shade during the susceptible period: that is, until the trees are about fifteen to twenty-five years of age or somewhere between twenty and thirty feet in height. The density of shade tolerated by white pine will vary with soil and moisture conditions, and therefore must be determined separately for each site. On the better soils in New York, and to a lesser degree in the Lake States, white pine reproduces itself well under the shade of mixed pine and hardwoods. It would, however, be necessary to liberate the young pines by means of thinning, in order to prevent their succumbing to the competition of the overtopping trees. On poorer soils it would be difficult, if not impossible to grow pines under hardwoods.

"Peirson (1922), as a result of experiments conducted in Massachusetts, also advises the growth of white pine in mixture with hardwoods in such a way that the pine will be slightly overtopped until it has reached the age of about fifteen years. In view of the fact that his experiments were carried on without knowledge of the work done around Ithaca or in Minnesota, it would appear that shading has received a double recommendation as a silvicultural method of control."

Numerous cases, however, where young pines under old hardwoods have been well weeviled, have been observed in the course of this study. It is believed that these cases were due, primarily, to a period of warm weather which resulted in the weevil attaining the leaders before the hardwood foliage had been produced. It was further noted that, where Pissodes was well established and abundant, the screening effect of overtopping hardwoods did not adequately protect the young pines from infestation. Under these conditions, then, it would seem that even the silvicultural approximation of a forest of natural mixed growth may not be effective always.

(c) Graham (1926) went further with the shading principle and, from the results of experiments, concluded that, if in pure stands of white pine" . . . a density of from 1200 to 1500 trees per acre is maintained throughout the early years of the rotation, and a fully stocked stand thereafter, then the loss resulting from the attack of the white-pine weevil will be at a minimum." Peirson (1922), independently, reached about the same conclusions. The points made for this method by Peirson include the tendency to a longer leader (tending to prevent its destruction below the first whorl), the increased growth of the stand resulting in a diminished period of susceptibility, and the increased possibility of weeviled trees overcoming their bayonet-shaped crooks. Coville (1923) disagrees with Graham (and Peirson); he says:

"... While varying densities may control the per cent of injury as these densities occur naturally over small areas, they do not control them to such an extent that two areas of the same density but of different localities will be injured the same. Graham possibly did not mean to infer this but merely to show the proportion on the particular tracts he studied. ... Where weevil damage is very prevalent damage seems to occur irrespective of density or spacing of trees. As a result, one can say that no change in the accepted spacing for a white pine plantation will do any good in combatting the pest directly."

While Coville's data may be insufficient to justify such positive conclusions, there is probably a large element of truth in his statement. In this study, it was noted in several cases that the *abundance* of the weevil seemed to be the critical factor in the degree of infestation. At North Beverly, Mass., for example, small plantations too dense to pass through were well weeviled, while other tracts with relatively widely spaced trees, were almost entirely free of infestation. (Again, these facts tend to indicate the accidental quality of the number of weevils that may arrive, presumably by flight, to begin operations in isolated young stands.) Doubtless, however, if the number of weevils is equal, Graham and Peirson are, in general, corect in regard to the lessened chances of Pissodes infestation in dense pure plantings over widely spaced ones.

Those authors, however, have not adequately considered the effect upon the soil nor the eventual effect upon the trees themselves by pure plantings of such density as 1500 trees per acre. Fisher's (1928) recent paper clearly points out the static condition and low fertility of the soil in pure stands. It would seem that dense planting is not wholly desirable. The opposite alternative of planting in dense stands is to space the pines widely and a number of foresters have advocated this policy for various reasons. Under these conditions, however, the weevil may be expected to infest heavily and to produce a crop of "pasture pines." Since a middle course between dense planting and wide spacing in pure stands would still result in weevil infestation, it is here suggested that of the several silvicultural methods, the mixed hardwood practice seems the most suitable in general, though each site should be treated only after a special study of local conditions of soil and the like.

After a survey of the work of the men who have been engaged in experiments in Pissodes control from a forestry viewpoint, it is still apparent, unfortunately, that even the type of shading given by planting white pine in mixture with hardwoods will not reduce the loss from weeviling to a negligible degree in all cases. Since the present methods of direct artificial control are too expensive for their use to be justified, the forester needs the benefit of other factors. In conclusion, it may be said that the large amount of work upon this serious pest, both in the past and in the present, and the present tendency of investigators to specialize upon definite phases of the general subject, augurs well, indeed, for the eventual adequate check of the white pine weevil, though no control, applicable to forest conditions, which is simple, inexpensive, and highly effective, has yet been determined.

The possible control of the weevil by parasites has merited study and the rest of this paper is devoted to these objectives:

a. The identities of the insect parasites of *Pissodes strobi.*
b. The salient facts of their individual biologies in so far as it was possible to obtain them.
c. A determination of the approximate effectiveness of each parasite.
d. A brief discussion of the feasibility of the utilization of parasites for the control of this great enemy of white pine.

B. THE INSECT PARASITES

I. Breeding Methods, Apparatus, and General Data Secured

Introduction

The importance of suitable apparatus for breeding and manipulating small parasitic insects cannot be overestimated when the complete failure of all experiments and the loss of all stocks may follow from a lack of a suitable environment. The methods and apparatus described in this section were arrived at by "trial and error," though in some instances the experience of others was freely drawn upon. The difficulties were considerable. It is hoped that any future workers with the parasites of *Pissodes strobi* may be aided by the technique and apparatus finally adopted.

Plan of Attack

The preliminaries of this study included: (1) The determination of the source of the parasites in the field; (2) the determination of the best time to collect material; (3) the forcing out of some parasites for early taxonomic identification; and (4) the development of methods for rearing, feeding, and manipulating the insects.

(1) It was assumed that those parasites which attacked the immature stages of the weevil would be associated with the host plants of the latter. Weeviled shoots of white pine were examined in late summer and non-curculionid cocoons and pupae in the pupal cells of Pissodes were noted. The weeviled leaders were thus established as a source of parasites in the field.

The first collection of material was made in October, 1926, at the Stony Brook Reservation, when about 200 withered white pine tops were taken. Some of these leaders were cut up and all supposed parasites and predators removed. (No data on incidental forms, whose presence was noted and which were preserved, are included in this paper, but a classified list thereof has appeared elsewhere.)[24] The tops which were not dissected were placed, laterals and all, on trays of coarse wire and tied down. The loaded trays were kept several feet above the soil in large screened cages to prevent attacks by birds and ground mammals. Under these conditions, the brush was subject to temperatures and humidities approximately identical with those prevailing on the collection

[24] Taylor, Raymond L. The arthropod fauna of coniferous leaders weeviled by *Pissodes strobi* (Peck). Psyche 35: 217–225. 1928.

tract, while stripping by birds was avoided. Throughout the winter, at intervals of one or two weeks, other batches of leaders were collected at Stony Brook and other localities within fifteen miles of the laboratory. It was determined, after a few shoots had been examined, that all parts of the top, except a portion of the leader and, occasionally, the basal parts of a lateral or two, were valueless as parasite material. The procedure followed in the field thereafter was to break or cut the terminal shoot just below the farthest limit of weevil advance, to lop off all unweeviled laterals, and to remove the apical portion of the leader itself wherever the diameter was less than the width of a pupal cell, or showed no indications of weevil pupation. In this way, the material was converted, essentially, into straight lengths of one to three feet in length which were readily handled and easily placed in the breeding cages.

It is worthy of note that a certain correlation between the appearance of the leader and its parasite contents was observed. It would be expected, of course, that a shoot with many exit holes might be less productive of parasites, usually, than one of well-weeviled appearance with few or no exit holes and, in general, this proved to be the case. Thin weeviled leaders, about three-eighths of an inch in diameter, proved to be the most productive of the chalcidoid, *Eurytoma pissodis* Gir.

(2) The early spring was eventually determined as the optimum time to collect to obtain hibernating parasitic forms, since absolutely natural conditions were thus allowed to prevail as long as possible. The loss of some parasites because of bird activity during the fall and winter was considered offset by the greater ease, and hence larger number of leaders per hour, of collection at this time; moreover, the drier, weathered leaders were more readily pruned and trimmed than in the fall. In naturally seeded stands, and especially under old hardwoods, the freedom from the herbaceous ground cover and the absence of hardwood foliage to obscure the vision are additional factors in the desirability of collecting in March and early April. To obtain parasites which emerge in the summer, the best time for collection was found to be not later than just before the adult weevils begin to emerge, and preferably a few weeks earlier.

Breeding Technique

(3) At the beginning of this study, it was deemed desirable to force out parasites as early as possible, not only for preliminary identification, but to determine satisfactory rearing methods in ad-

vance of the normal emergence, if possible. The prepupae and cocoons dissected out in the fall of 1926 were placed in glass test tubes, six by one inches, which had the closed end burned out. At the wide, shouldered end, the tubes were sealed with plaster of Paris to a depth of about one-quarter of an inch; the smaller hole at the other end was plugged with non-absorbent cotton. In general, six to twelve prepupae, or two or three small sections of the shoot which contained cocoons, were placed in each tube; the tubes were then placed in wire racks which were installed on a well-shaded shelf in a small outbuilding where the temperature was that of outdoors. At the end of December, after the several weeks of freezing weather which were considered sufficient to have the necessary physiological effect upon the insects, the tubes were removed to a greenhouse and placed under a table where the light was dim. The greenhouse temperature ranged from 45 to 78° F.; the routine waterings of twice per week apparently provided sufficient moisture to penetrate the plaster. Under these conditions, the emergence of these forced parasites ranged as follows:

Microbracon pini Mues.	Feb. 7 to Apr. 8
Coeloides pissodis (Ashm.)	Mar. 4 to Mar 11
Eurytoma pissodis Gir.	one female, Apr. 8
Eupelmus pini Taylor	one female, Apr. 23

For those forms in cocoons, the tubes proved satisfactory, but for the naked prepupae of Eurytoma, they were unreliable indeed. During January and February several hundred of this chalcidoid fell prey to that voracious mite, *Pediculoides ventricosus* (Newport); an account of this has been published elsewhere.[25] Despite cullings and subsequent isolation in sterile tubes, all the prepupae were destroyed; of the total lot, only five reached the pupal stage and but one the adult stage, before they succumbed. Unless extreme precautions to avoid mites[26] are observed, it is entirely impractical to rear Eurytoma as described.

[25] Taylor, Raymond L. Notes on the mite, *Pediculoides ventricosus* Newport. Psyche 34: 157–163. 1927.

[26] The mite was unnoticed at the time the *Eurytoma* prepupae were placed in the rearing tubes and no particular precautions were taken. In the tubes there was considerable débris, consisting of particles of decayed bark and wisps of wood formed by the weevil larvae. Without doubt, mites were in the débris at this time.

When the prepupae were culled and isolated in sterile tubes, however, individual examinations were made, but in each case mite infestation developed. It seems probable that *Pediculoides* was

(4) The forced parasites were transferred to cotton-plugged, half-pint bottles by removing the cotton plug and quickly placing this end of the tube within the mouth of the bottle; the transfer of the positively phototropic parasites was usually expedited by the tube opening and bottle being turned toward a source of light. For counts of large numbers or the separation of mixed lots, etherization was resorted to and this method proved highly satisfactory.

The food decided upon from the first was some proportion of honey and water. Honey, which contains several sugars, seems a good food for various parasites and has been used by many workers. To avoid fermentation, the honey and water were mixed at the time of feeding, and this was accomplished by placing drops of each upon small strips of white blotting paper. One strip was used for each bottle and one or two strips of filter paper were added to make the absorption of excess water more certain. The strips were renewed at each feeding and the old ones discarded. In smaller containers, one alternate drop of honey and one of water were placed directly on the glass by the tip of a coarse probe. Care was employed to prevent the use of too much honey since parasites easily get stuck in their food. In the lamp-chimney cages kept in the light in the laboratory, where evaporation was rapid, it was found advantageous to spread the honey and water mixture upon cover glasses rather than on blotting paper. In all cases, when containers became sticky or slightly fermented, the parasites were transferred to sterile bottles or vials. The feeding interval was once every two or three days or whenever needed; in the dark, or in the ice-box, the activity of the parasites and resultant food requirements were such that feedings of once per week or ten days were quite sufficient.

It was necessary that the white pine tops, which had been kept on trays in cages over winter, as described, be transferred to smaller

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able to infest a prepupa for several days without any evidence of its presence, since, though each prepupa was brushed and examined carefully before isolation, the mite invariably appeared. It is also probable that a prepupa at the time of its transference might have had upon its surface one or several mites which survived the brushing and escaped notice. That the acarid could remain unnoticed is at least possible because of its minute size, pale color, and semitransparency when young. It is also possible that it may penetrate into the spiracles of the prepupa and thus readily escape attention.

cages with provision for the capture of the emerged parasites. The following type of breeding cage was devised. The larger end of a six-inch flower pot was glued to a sheet of glass that had been opaqued with paint. Weeviled leaders were broken into pieces of suitable length and ten to twenty of these pieces were inserted in each pot through the hole in the smaller end. A test-tube with the end burned out was then glued over the flower pot aperture so that the cotton-plugged smaller end was uppermost. Positive phototropism was relied upon to cause the passage of the parasites up into the tubes. In late February, a series of these pot-cages were placed on a table in a greenhouse where the temperature ranged from 40 to 80° F. The pots were watered once or more per week and apparently the humidity of the interiors was favorable for the emergence percentage of the parasites was high.

It became evident that the material had been removed to the greenhouse too early in the season for, in less than two weeks, the first parasites were obtained. The transfer of parasites in the tubes to bottles was readily accomplished. The emergence ranged as follows:

Microbracon	—Mar. 9 to Mar. 28
Eurytoma	—Mar. 18 to Apr. 30
Eupelmus	—Mar. 18 to Mar. 23
Coeloides	—Mar. 20 to Mar. 25

These pots, while they proved satisfactory for forcing small quantities, were not considered for large breedings and an entire room and a simpler and more capacious type of cage were adopted to obtain parasites in quantity.

To secure more parasites for experimentation in 1927, collections were made in April and May and the leaders, broken into pieces, were placed in milk bottles covered with scrim held in place by rubber bands. Though the bottles were placed in a cold frame to keep out rain, the amount of moisture condensed on the inside of the bottles was considerable. This type of breeding cage proved very unsatisfactory, since, in addition to the loss of some parasites by drowning in this condensed water, their transfer was much more laborious than desirable. Lamp-chimneys, screened at both ends with scrim and kept in a horizontal position, were more efficient but the labor of transference was not reduced. With these cages under temperature conditions approximately those in the field, the initial emergence of the several forms was:

Microbracon pini Mues.	May 9
Lonchaea corticis Taylor	May 12
Eupelmus pini Taylor	June 3
Coeloides pissodis (Ashm.)	June 3
Eurytoma pissodis Gir.	July 12

A room on the second floor of an untenanted structure on the grounds of the Bussey Institution was chosen for breeding out the parasites in quantity. The single window was removed and the opening screened with two thicknesses of substantial scrim tacked to the inside woodwork. The empty room was made tight by sealing all crevices with gummed paper strips, such as are used for sealing packages. In this manner, a closet door, a trap door into the attic, and the edges of the scrim screen were all carefully sealed. Since the floor appeared tight it was not treated except for an apron of heavy manila paper below the screen. The primary purpose of these preparations was not so much to prevent the escape of the positively phototropic parasites as to prevent the ingress of spiders and unwanted insects. A series of horizontal strings was stretched along the length of the room nine inches apart; future sagging was compensated for by vertical strings secured to the ceiling. About 2700 pruned leaders, largely unbroken, were piled against the strings at acute angles in alteration, or in the form of a *chevaux de frise*. Small lengths were laid crosswise over two strings, while small fragments were placed between the alternately inclined leaders. In this way, compactness, with considerable light and air between the shoots, was secured. Natural conditions of temperature and humidity were closely approximated in this room. To compensate for lack of direct rainfall, the leaders were occasionally sprinkled with water.

The collecting screen proved an excellent means of capturing the parasites, for it was a comparatively simple matter to slip shell vials over the larger insects, or to brush the smaller ones into the vials with a small, long-handled brush, and then to insert the cotton and cheesecloth plugs. An ideal feature of the screen was the opportunity afforded for classifying and selecting forms before placing them in vials.

Daily collections were made in the late afternoon. The number of parasites taken in a single day ranged as high as 400–odd; the total number of the spring emergence of parasites in this room was 4115, while 856 predacious clerids and a number of other insects were taken. The interesting miscellany of spiders and incidental insects, unconnected with Pissodes, have been listed elsewhere, as noted.

All spiders, largely immature forms, were collected promptly to avoid destruction of any of the parasites. Since the majority of the spiders sought the walls of the room, their capture was not difficult; any that spun webs on the leaders were thus located and destroyed. It is believed that in no single instance did a parasite fall prey to these partly grown spiders on or near the screen, and, also, that any loss, which may be attributed to spiders on the shoots, was negligible. If spiders be eliminated from such material as soon as they emerge, the rearing of the white-pine weevil parasites on a large scale, under similar conditions, should be eminently feasible.

Some of the general data obtained from the breeding room are shown in the following table:

TABLE 7

The Order of Emergency, and the Quantity, of the More Important Parasites Obtained from the Breeding Room

Order	Name	First date	Last date	No. males	No. females	Total
1	*Calliephialtes nubilipennis*	May 14	June 2	12	0	12
2	*Lonchaea corticis*	May 16	July 17	385	297	682
3	*Microbracon pini*	May 17	June 27	594	622	1216
4	*Rhopalicus pulchripennis*	May 27	June 28	51	7	58
5	*Pleurotropis* n. sp.	June 3	July 26			54
6	*Eupelmus pini*	June 3	July 9	83	229	312
7	*Coeloides pissodis*	June 13	July 4	5	28	33
8	*Eurytoma pissodis*	June 13	July 25	529	1116	1645
9	*Eucoila* sp.	June 29	July 9			21
				Grand total		4033

Note: 94 parasites representing 21 species are not included here, but are listed separately in the next section, B II.

A striking point is the specificity of each species in its emergence; the order of emergence did not vary in three seasons.

Material secured from other states was placed in breeding cages patterned after a type found most successful by Barnes. These cages consisted of galvanized iron sheeting, number 26 gauge, rolled into cylinders six inches in diameter and three feet long; a few were sixteen inches long since the standard size sheet purchased yielded four regulation cylinders and one short one. The cost of these cylinders made up was $3.05 per lot of five. One end of each cylinder was covered with a good grade of opaque black sateen (40 cents per yard) tightly wired on; on the other end, a seven inch tapered sleeve of the same material was wired on, while the smaller free end of each sleeve was fitted over the shoulder of a pint size glass jar and tightly secured by string. Later, when the parasites began to emerge, rubber bands were used to facilitate slipping the bottle in and out. Two batteries of these cages, most with an optimum capacity of about 24 full-length pruned leaders, were arranged so that the bottles lay upon a right-angled board; a site with a slight slope was chosen to permit drainage of rain water. The batteries of cages were covered with heavy carboard, weighted down, to prevent undue heating by solar radiation. When insects appeared in the glass jars, it was a comparatively simple matter to remove the jars, screw on the covers, and insert other jars into the sleeves. The jars with the emerged parasites were then removed to the laboratory where, by etherization, classifications, counts, and transfers to shell vials were made. These cages proved entirely satisfactory for breeding out the parasites but the daily labor of collection consumed considerable time. It is suggested, when a large quantity of material from one locality is to be dealt with, or when the source of the material is not important experimentally, that a tight room and a collection screen is more advisable. Occasionally, after a heavy rain followed by hot sunlight, moisture would condense on the inside of the jars but this condition was easily corrected by the substitution of dry jars. A few spiders were removed from the cages as soon as noted.

The chief purpose of breeding out parasites in the cages just described was to obtain data concerning their distribution but after the parasites emerged, they were used on terms of equality with those obtained from the breeding room. In a number of cases individuals from widely separated localities were introduced together in vials to note whether mating was less likely between "geographical strains" of what were apparently the same species. In all cases observed, if the local individuals would mate in captivity, individuals of the same species from sources distant from each other would mate also, so that there was no apparent difference; *e.g.*, a female *Calliephialtes nubilipennis* from Fayetteville, Pa., mated with a male from Boston, and females of *Microbracon pini* proved amenable to the advances of males from all the other states represented.

In an attempt to obtain further distribution data, leaders from Garrett County, Md., and from Morris County, N. J., were dissected, and shoots were dissected in the field at Boyce, Clark County, Va. *Lonchaea corticis* was found in the Maryland material, while in the last, *Eurytoma pissodis* was noted. In these cases, identification of these common forms was based upon the appearance of the immature stages. A list of emergents from the breeding cages follows (pp. 215 and 216).

The conservation of the parasites proved a problem of some magnitude. For the sake of greater convenience and to prevent undue losses from molds and the like, the insects were kept in shell vials, 21 x 66 mm. in size; as a rule, 30 was the maximum number of the smaller forms kept in a single vial. With the use of many such small containers, it was convenient to keep lots under different conditions of temperature, to segregate the sexes, to maintain stocks of both fertilized and unmated females, and the like.

Most of the stocks, which were placed in wooden trays holding 12 vials, were kept on shelves above the ice in an ice-chest. This course was necessary to prevent death or lack of vigor before the optimum time for parasitization in the case of those forms which emerged early. The experience of the previous season showed that, at room temperature, even in darkness, a majority of Microbracon, for example, would be lost. Molds, such as an *Aspergillus* species and a *Penicillium* species, proved very troublesome. The wooden trays in the ice-chest absorbed moisture and afforded an opportunity for the fungus spores to germinate. When this occurred, several vials at one end of each tray often became covered with hyphae and it became necessary to transfer the parasites. Vials not changed promptly became infested as the hyphae penetrated past the loose cotton plugs. Apparently the parasites were enfeebled and killed by the fungi; at least, it may be said definitely that the dead parasites in the vial, which were more numerous than usual, were quickly covered by the invading mycelia and that fruiting bodies were formed similar to those on moist wood.

With lower temperatures, with trays composed of some substance other than wood, or of wood treated with a fungicide, the elimination of molds in refrigerators may be approached. In this study, wire racks to hold the vials and a metal shield to catch condensing moisture placed over them, proved satisfactory as emergency measures. Molds in the oviposition cages were checked by decreasing the available sources of moisture, while an attempt was

TABLE 8

The Parasites of *Pissodes* Obtained from the Breeding Cages

Cage No.	No. shoots	Material	Source	Date caged	Number of parasites							Total
					Eury.	Mic.	Lon.	Rho.	Coe.	Pleur.	Euco.	
1	24	*Pinus strobus*	Readfield, Me.	3/7	11*	4	39			65		119
2	32	*Pinus strobus*	China, Me.	3/7	33*	5	24		8	56	6	132
3	42	*Pinus strobus*	Sidney, Me.	3/7	19*	7	11		2	101	1	a142
4	35	*Pinus strobus*	Oneonta, N. Y.	3/29	32	3	154	2	1*	199	10	b403
5	4	*Pinus sylvestris*	Oneonta, N. Y.	3/29	1	5	25			3	1	35
6	15	*Pinus strobus*	E. Greenwich, R. I.	4/5	1		9		2	26	1	39
7	6 1	*Pinus strobus* *Pinus sylvestris*	McConnellsburg, Pa.	4/9	7		2		2	19		30
8	2 7	*Picea abies* *Pinus strobus*	Wellsboro, Ansonia, Pa.	4/13	11	7	12			19	1	50
9	22	*Pinus strobus*	Sizerville, Pa.	4/17	24	6	24			89		143
10	2 12	*Pinus strobus* *Pinus strobus*	Mifflinburg, Milroy, Pa.	4/17	2		56			90	6	154
11	1	*Picea abies*	Mifflinburg, Pa.	4/17			6					6
12	7	*Pinus strobus*	Blain, Pa.	4/21			3			10	1	14
14	13	*Pinus strobus*	''Northwest'' Conn.	4/21	14	3	1			27		45
15	23	*Pinus strobus*	Fayetteville, Pa.	4/24	23	12	7			41	4	c91

TABLE 8—(*Continued*)

Cage No.	No. shoots	Material	Source	Date caged	Number of parasites							Total
					Eury.	Mic.	Lon.	Rho.	Coe.	Pleur.	Euco.	
16	12	*Pinus strobus*	Mont Alto, Pa.	4/29	4	4	2		2	16		28
17	15	*Pinus strobus*	Concord, N. H.	5/3	25	1	43			43	14	126
18	13	*Picea abies*	Ann Arbor, Mich.	5/6	32		4	2		6	1	45
19	32	*Pinus strobus*	Brådford and vicinity, Vt.	5/10	36*	12	42			62	1	153
20	21	*Pinus strobus*	Durham, N. H.	5/10								
21	16	*Pinus strobus*	Durham, N. H.	5/12	9	30	408		2	30	16	495
22	12	*Picea abies*	Roscommon, Mich.	5/14	27	1	12	8			1	49
23	14	*Pinus strobus*	Roscommon, Mich.	5/14	24	1	27	1		4		d58
24	29	*Pinus strobus*	Mentor, O.	6/1	45					24		69
Total 23	412	Three species	Nine states		380	101	911	13	19	930	64	e2426

* Parasites which were found stuck in the shoots after their dissection have been added to the number of those which emerged. The asterisk indicates in *each* case that *one* individual of the species is included in the number given.

"a" The total includes 1 *Calliephialtes nubilipennis.*

"b" The total includes 2 *Eupelmus pini.*

"c" The total includes 4 *Calliephialtes nubilipennis.*

"d" The total includes 1 *Calliephialtes nubilipennis.*

"e" The grand total includes 2 *Eupelmus pini* and 6 *Calliephialtes nubilipennis.*

made to do this in the life-history glass cell slides also. In all the parasite cultures, however, the struggle to maintain an optimum humidity for the parasites was an appreciable one and there were losses due to fungi from excessive moisture on the one hand, and others due to desiccation because of insufficient moisture on the other.

Copulation of parasites was usually arranged to take place in the shell vials since the females had less space in which to avoid the males, and since observation under the binocular was possible. Copulation in the oviposition cages throughout the period of confinement was common in many of the species.

The type of oviposition cage devised consisted of a seven inch lamp-chimney placed in dry sand contained in a flower pot. The tops of the chimneys were screened with taut scrim securely tied and were darkened, when moisture conditions permitted, by metal caps (the covers of the jars used in the breeding cages). A two ounce bottle, filled with water, was embedded in the sand to keep the leader fresh; over the mouth of the bottle and around the shoot was placed a circle of cardboard designed to prevent drowning of the parasites. A portion of a leader, cut about five inches below the limit of weevil advance, and about eight or nine inches long, was forced through the cardboard and placed in the bottle; the lamp-chimney was then stocked with parasites and fitted over the shoot. These cages were kept in the laboratory at the prevailing room temperature in June and early July. Feeding of the parasites was accomplished by placing an ordinary glass cover slip, on which had been placed a few drops of honey and water, on the cardboard platform of each cage. Food was replaced whenever the slips became dry, or every two or three days. The shoots were kept in the cages for periods of one to ten days; the cages were usually restocked with fresh parasites when new leaders were introduced.

A single objection to this type of oviposition cage was the amount of moisture that condensed upon the inner sides of the glass chimneys. The amount of water transpired by a leader denuded of all needles was surprising and necessitated at least a daily wiping of the glass with a dry cloth. It was found that, if the shoots were not left in the cages longer than six days, placing the leaders in moist sand alone would keep the material sufficiently fresh while the formation of molds was discouraged. On the whole, these cages proved quite satisfactory for the parasites which would oviposit. Auxiliary cages, which consisted of lamp-chimneys screened with scrim at both ends, filled with one or more dry shoots, and placed in a horizontal position, proved satisfactory for short periods and more readily permitted withdrawal of the female for microscopic examination during the act of oviposition.

The leaders to be parasitized were taken from an area in the Stony Brook Reservation that had been cleaned of weeviled leaders for two successive years and which were assumed, from trial dissections, to be relatively free from parasite eggs or larvae at the time of their introduction; in only one instance were older parasitic forms originated under natural conditions noted. After a definite time, the shoots were removed from the cages, the bark was carefully peeled away, and all eggs and early stage larvae not those of *Pissodes* were removed to the life-history slides.

The rearing through of the parasites from eggs or early instar larvae proved exceedingly difficult. The apparatus selected was patterned after the glass cell slides of C. M. Packard (1916) which were used with 60 per cent effectiveness by Phillips and Poos (1921) in rearing Hessian fly parasites. The slides used were larger and consisted essentially of strips of glass, 3.5 x 1 x .25 inches with three cells, each one-eighth of an inch deep, one-eighth wide, and about three-eighths of an inch long, ground in one inch apart. Weevil larvae, one to a cell, with the eggs or young larvae of the parasite, were placed in these cells and roofed over with a glass cover slip per cell, held in place by two droplets of honey. These life-history cell slides were kept in a drawer in the laboratory and brought out once or twice a day for observation. Under these conditions, desiccation of both host and parasite occurred. To avoid this, the slides were broken into units of one or two cells and placed in petri dishes with a few drops of water near the slides. Under these latter conditions, the weevil larvae kept fresh for a longer time but many of the cultures became infested with an *Aspergillus* mold. The difficulties with desiccation and mold prevented a series of systematic observations at measured intervals. In no case, for example, was it possible to hatch a parasite egg in these cells slides. It thus became necessary to allow the eggs to hatch in the leader in the oviposition cage before introducing the parasite and host in the slides. Cell slides in petri dishes proved satisfactory in a minority of cases, for it was possible to rear some of the young parasite larvae through to the pupal stage, and some became adults the same summer.

In those cases where oviposition could not be obtained, notably *Lonchaea corticis,* supplemental studies were made with field material.

To determine what parasites completed their development and emerged the same summer in the field, 335 leaders from an area in the Blue Hills Reservation near Milton hitherto uncollected from, were caged in the galvanized breeding cages previously described. This summer emergence was scanty but included a majority of the species obtained in the spring.

The parasites which emerged in the summer were placed in oviposition cages for observation since, even if actual oviposition was rendered difficult or impossible because of the position of the weevil larvae in their pupal cells, reactions to the leaders were sought.

The breeding cages which contained the 335 leaders of the summer collection were kept outdoors until mid-January and then removed to the greenhouse to force out all parasites that were hibernating as prepupae or pupae. In this way, since the parasites began to emerge in early February, a rough proportion of summer emergents to the spring emergents was obtained for each species. These data are given in the following table (p. 220).

To study the fate of the mature weevil larvae from another viewpoint, it was decided to dissect all of the leaders of the preceding year, both in the breeding cages and in the breeding room. This was done, a series of counts made, and a final figure, which would give a check on the effectiveness of the parasites, collectively, was determined. It was, of course, not possible in such a count to deal with any stage of *Pissodes* earlier than mature larvae which had constructed pupal cells or had, at least, begun them.

The method followed was simple: First, the exit holes were counted and all Type Three pupal cells, where the bark was torn in the characteristic manner, were ascribed to predatism by birds. Each leader was then halved and all the cells of the three types counted; stuck adults and pitch-drowned larvae were next counted; and, finally, the total of these was deducted from the total number of pupal cells. The figure thus obtained represented an approximate maximum for parasitism and predatism other than by birds. Often the exit holes of the parasites furnished a check for this "remainder" in individual shoots.

Counts of the few stuck or unemerged parasites were made and the puparia of *Lonchaea* and cocoons of *Microbracon,* as well as the number of pupal cells in which they were found, were also counted;

TABLE 9

The Proportion of Summer Emergents to Spring Emergents among the Parasites of *Pissodes*

Species	Summer				Spring			Proportion of totals
	date	males	females	total	males	females	total	
Microbracon	7/18–8/18	14	64	78	61	70	131	About 1: 1.7
Rhopalicus	7/18–8/13	1	13	14		5	5	About 2.8: 1
Coeloides	7/21–7/29	1	3	4	1	4	5	4: 5
Eucoila sp.	7/25–7/29	1	1	2			2	1: 1
Eurytoma	8/1–8/9	2	6	8	57	121	178	About 1: 22.2
Lonchaea	8/4–9/6	45	60	105	47	31	78	About 1.3: 1
Spathius sp.	8/30	4	8	12				

Where two dates are given, they are respectively the first and last date on which emergence was obtained in the summer. Spring dates are not given since the parasites were forced.

thus, an average number per host under natural conditions could be obtained for these species.

In the case of thick leaders, the shoots were quartered. These counts were more or less subject to some error but, on the whole, considerable care was taken to obtain reliable figures. With the conclusion of this laborious task, the data were added up and are here summarized.

TABLE 10
The Number of *Pissodes* Parasites per Host Found in Nature

Species	No. of cocoons or puparia	No. of weevil pupal cells	Average no. of parasites per host
Microbracon pini	948	431	2.2
Lonchaea corticis	1347	679	1.9

It will be noted that the percentage of the "remainder" is higher in the breeding cages than in the Massachusetts material, and, conversely, that the emergence percentage of the former is lower. A partial explanation of this may be found when it is considered that the leaders collected in other states were more or less selected stock, *i.e.*, well-weeviled shoots with few exit holes were requested. The possibility exists that the control of Pissodes by its parasites may have been less on the tract studied than in general elsewhere, but it would be unsafe to generalize in regard to the percentage of parasitism in states represented by such comparatively small samples. While the Massachusetts material, which was studied intensively, was a larger sample, the data obtained is not held to be more than an approximation of the degree of weevil parasitism around Boston in 1927.

It seems noteworthy that a close agreement in the percentage of larval consumption by birds, adults stuck in their pupal cells, and larvae drowned in pitch, was shown between the Massachusetts material and that of the nine other states taken collectively.

The "remainder," or total number of mature weevil larvae not otherwise accounted for, may be taken as the *maximum* amount that can be ascribed to insect parasites and insect predators. Since this figure, however, includes possible losses due to molds, bacteria, and other natural agents, it is apparent that the true figure for parasitism would be somewhat less. The *minimum* amount of con-

TABLE 11

A Statistical Determination of the Natural Control of Mature *Pissodes strobi* Larvae

Source	No. shoots	No. pupal cells	Emergence	%	Bird predatism	%	Stuck adults	%	Pitch-drowned larvae	%	Remainder	%
Sidney, Me.	42	353	128	36.26	55	15.68	23	6.51	3	.85	144	40.79
Oneonta, N. Y.	35	568	200	35.21	76	13.38	32	5.63	11	1.93	249	43.82
E. Greenwich, R. I.	15	152	88	57.89	20	13.15	14	9.21	5	3.28	25	16.44
McConnellsburg, Pa.	7	47	13	27.66	6	12.76	4	8.51	2	4.26	22	46.80
China, Me.	32	381	141	37.00	79	20.73	23	6.03	8	2.09	130	34.12
Ansonia, Pa.	9	74	27	36.48	1	1.35	5	6.75	2	2.70	39	52.70
Readfield, Me.	24	341	100	29.32	83	24.34	28	8.21	3	.87	127	37.24
Sizerville, Pa.	22	210	67	31.90	24	11.43	17	8.09	20	9.52	82	39.04
Concord, N. H.	15	215	72	33.48	50	23.25	6	2.79	5	2.32	82	38.13
Durham, N. H.	37	645	329	51.00	16	2.48	27	4.18	2	.31	271	42.01
"Northwest" Conn.	13	69	16	23.18	20	28.99	2	2.89	4	5.79	27	39.13
Milroy, Pa.	14	167	44	26.34	15	8.99	10	5.98	9	5.38	89	53.29
Bradford, Vt.	32	431	99	22.97	127	29.46	17	3.94	8	1.85	180	41.76
Mentor, O.	29	214	50	23.36	41	19.15	19	8.87	12	5.60	92	42.99
Mont Alto, Pa.	12	174	44	25.28	75	43.10	8	4.64	4	2.32	43	24.71
Fayetteville, Pa.	23	213	43	20.18	75	35.21	4	1.87	13	6.10	78	36.61
Roscommon, Mich.	26	237	77	32.49	30	12.65	9	3.84	7	2.95	114	48.10
Ann Arbor, Mich.	13	65	18	27.69	5	7.69	4	6.15	0	0.00	38	58.46
Blain, Pa.	7	29	8	27.58	3	10.34	2	6.89	1	3.45	15	51.72
Total of other states	407	4585	1564	34.11	801	17.47	254	5.55	119	2.59	1847	40.29
Mass.	2602	31351	16149	51.82	5534	17.65	1148	3.66	763	2.12	7757	24.74
Grand total	3009	35936	17713	49.29	6335	17.62	1402	3.90	882	2.45	9604	26.72

trol that could be credited to the parasites would be based solely upon the number of parasites and predators bred out. In determining this minimum, it becomes necessary to employ the coefficients given in Table 10 for those forms not on a one-parasite-per-one-host basis. An estimation of the summer emergence of 1927, based upon the proportions given in Table 9, has been added to the counted emergence of 1928 in order to secure a closer approximation of the degree of parasitism in the 1927 material. Table 12 represents an attempt to ascribe as definite a value to the effectiveness of each parasite and predator as is possible. In this table all parasites are calculated on a "unit" basis per single host with the following values:

Eurytoma pissodis	1	parasite per host
Microbracon pini	2.2	parasites per host
Lonchaea corticis	1.9	parasites per host
All other primaries	1	parasite per host

Pleurotropis n. sp., a secondary, was estimated as 3 per *Lonchaea,* or indirectly, 5.7 per weevil larva.

The clerid predators are arbitrarily taken on a basis of 1 per weevil larva though this is probably an underestimation. *Dioryctria* n. sp. is considered on a basis of 1 per 5 weevil larvae.

A relatively small number of stuck parasites has been added to the spring emergence; this number is based upon the actual number found in the dissected shoots:

Readfield, Me.	1	*Eurytoma pissodis*
China, Me.	1	*Eurytoma pissodis*
Sidney, Me.	1	*Eurytoma pissodis*
Oneonta, N. Y.	1	*Coeloides pissodis*
Bradford, Vt.	1	*Eurytoma pissodis*
Massachusetts	18	*Eurytoma pissodis*
	2	*Microbracon pini*
	4	*Lonchaea corticis*
	3	*Coeloides pissodis*

In this following table, the percentages listed pertain to the total number of *mature weevil larvae* in the leaders and are *not* percentages of the weevil larvae "previously not accounted for".

In Tables 11 and 12 it has been shown that the number of otherwise unaccounted for weevil larvae in the dissected leaders of the 1927 infestation, attributed to parasites, insect predators, and molds and other minor factors, was about 25 per cent of the mature larvae (a) at Boston, Mass., and environs, while (b) in nine other states (based on small samples averaged together), this number was about 40 per cent. In Table 12 the figures for the parasites (counted and estimated) were about 13 per cent and 40 per cent of the mature weevil larvae, respectively; those for the predators, about 3 per cent and less than 1 per cent, respectively.

It may be noted that, when the sum of the totals ascribed to parasitism and predatism is subtracted from the number of weevil larvae "previously not accounted for," a "discrepancy" is the result in each case. These differences, when large, proportionately, serve to emphasize the impossibility of closely evaluating some of the variables that enter into such a problem. The estimation of the maximum parasitism and predatism, based upon the dissection of the leaders, was obtained in a negative way, *viz.*, by the subtraction of certain positive items from the approximated total number of mature weevil larvae in the leaders. This remainder naturally tends to include weevil losses from factors which could not be measured. On the other hand, the counts of the parasitic and predacious forms, while positive enough for the spring emergence, were reduced in exactness by the addition of the estimated summer emergence, which very probably varies considerably in different localities and from year to year. In general, it is probable that much of these discrepancies may be explained by the supposition that parasites, which had destroyed weevil larvae and pupae, fell prey to predacious forms, particularly birds which work the leaders all winter, and thus did not appear in the emergence totals. In several instances, where the discrepancy is on the other side, or where more parasitism is ascribed than is supported by the data from the dissected leaders, it is very probable that the estimated summer emergence, particularly of *Lonchaea* or *Rhopalicus,* was excessive in those instances.

In spite of these discrepancies, the foregoing tabulated data is as close an approximation of the degree of parasitism which existed in eastern Massachusetts in 1927 as could be obtained. It is believed that the results of this survey may be used as a reliable basis for the following conclusions:

1. The native insect parasites of *Pissodes strobi* are a factor of limited value in the control of this insect since in about 3000 leaders of the 1927 infestation they were responsible for about 16 to 27 per cent of the *mature* weevil larvae.

2. Collectively, the parasites rank very close to birds in percentage of effectiveness in the control of the weevil.

ɔrs of *I*

ɜs	Pleurc
	No.
9	17.7
	35.4
	4.6
	3.3
	9.8
	3.3
	11.4
	15.6
	7.5
	5.3
	4.7
	15.8
	10.9
	4.2
	2.8
7	7.2
2	0.7
	1.1
	1.7
3	163.0
4	9.5
5	172.5

TABLE 12

An Estimation of the Effectiveness of the Parasites and Predators of *Pissodes strobi.*

Locality	Total number pupal cells	Previously not accounted for		No. ascribed to:		Total number ascribed to individual parasites:																Total ascribed to parasitism:		Number ascribed to each predator:						Total ascribed to predatism		Total parasitism and predatism		"Discrepancy"	
				Spring parasites	Summer parasites	Eurytoma		Lonchaea		Microbracon		Eupelmus		Rhopalicus		Coeloides		Calliephialtes		Pleurotropis				Hydnocera		Placopterus		Dioryctria							
		No.	%			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Sidney, Maine	353	144	40.79	50.7	11.2	22.0	6.23	12.6	3.57	5.0	1.41					3.6	1.02	1	.29	17.7	5.01	61.9	17.53									61.9	17.53	82.1	23.26
Oneonta, N. Y.	568	249	43.82	171.2	132.6	34.5	6.07	216.6	38.13	5.9	1.04	2	.35	7.6	1.33	1.8	.31			35.4	6.23	303.8	53.47									303.8	53.47	–54.8	(9.65)
E. Greenwich, R. I.	152	25	16.44	12.3	7.8	1.0	.65	10.9	7.17							3.6	2.35			4.6	3.02	20.1	13.22									20.1	13.22	4.9	3.22
McConnellsburg, Pa.	47	22	46.80	13.4	3.3	7.3	15.53	2.5	5.31							3.6	7.66			3.3	7.02	16.7	35.53									16.7	35.53	5.3	11.27
China, Maine	381	130	34.12	63.7	24.8	33.4	8.76	29.0	7.61	3.7	.97					12.6	3.30			9.8	2.56	88.5	23.23									88.5	23.23	41.5	10.89
Ausonia, Pa.	74	39	52.70	23.8	10.6	11.5	15.51	11.5	19.59	5.1	6.89									3.3	4.46	34.4	46.49									34.4	46.49	4.6	6.21
Readfield, Maine	341	127	37.24	44.7	28.1	11.5	3.37	47.1	13.84	2.8	.82									11.4	3.34	72.8	21.35									72.8	21.35	54.2	15.89
Sizerville, Pa.	210	82	39.04	54.9	19.0	25.0	11.90	29.0	13.81	4.3	2.04									15.6	7.42	73.9	35.19									73.9	35.19	8.1	3.85
Concord, N. H.	215	82	38.13	55.6	30.8	26.1	12.14	52.0	24.18	0.8	.37									7.5	3.48	86.4	40.18									86.4	40.18	–4.4	(2.04)
Durham, N. H.	645	271	42.01	214.5	288.9	9.4	1.45	493.5	76.51	21.6	3.34					3.6	.55			5.3	.82	533.4	82.69					15	2.32	15	2.32	548.4	85.01	–277.4	(43.00)
"Northwest" Conn.	69	27	39.13	20.6	2.2	14.6	21.16	1.2	1.73	2.3	3.33									4.7	6.81	22.8	33.05	1	1.44					1	1.44	23.8	34.49	3.2	4.64
Milroy, Pa.	167	89	53.29	47.3	38.5	2.1	1.25	67.9	40.65											15.8	9.46	85.8	51.38									85.8	51.38	3.2	1.91
Bradford, Vt.	431	180	41.76	74.5	33.4	37.5	8.70	50.8	11.78	8.7	2.01									10.9	2.50	107.9	25.03									107.9	25.03	72.1	16.73
Mentor, Ohio	214	92	42.99	49.2	2.0	47.0	21.96													4.2	1.96	51.2	23.92									51.2	23.92	40.8	19.07
Mont Alto, Pa.	174	43	24.71	11.7	4.2	4.2	2.41	2.5	1.43	2.8	1.61					3.6	2.07			2.8	1.61	15.9	9.14	1	.57					1	.57	16.9	9.71	26.1	15.00
Fayetteville, Pa.	213	78	36.61	43.4	9.0	24.0	11.27	8.5	3.99	8.7	4.08							4	1.87	7.2	3.38	52.4	24.59	1	.47	1	.47			2	.94	54.4	25.53	23.6	11.08
Roscommon, Mich.	237	114	48.10	83.1	49.1	53.3	22.49	47.1	19.87	1.4	.59			28.7	12.11			1	.42	0.7	.29	132.2	55.78									132.2	55.78	–18.2	(7.68)
Ann Arbor, Mich.	65	38	58.46	37.2	9.8	33.5	51.54	4.8	7.39					7.6	11.69					1.1	1.69	47.0	72.30									47.0	72.30	–9.0	(13.84)
Blain, Pa.	29	15	51.72	3.3	2.1			3.7	12.75											1.7	5.86	5.4	18.62									5.4	18.62	9.6	33.10
Total of other states	4585	1847	40.29	1105.1	707.4	397.9	8.68	1094.2	23.86	73.1	1.59	2	.04	43.9	.95	32.4	.71	6	.13	163.0	3.55	1812.5	39.54	3	.07	1	.02	15	.32	19	.41	1831.5	39.95	15.5	.34
Massachusetts	31351	7757	24.74	3005.1	1056.5	1733.4	5.53	830.3	2.65	879.2	2.80	312	.99	220.4	.70	64.8	.26	12	.04	9.5	.03	4061.6	12.95	524	1.67	332	1.06	90	.29	946	3.02	5007.6	15.97	2749.4	8.77
Grand Total	35936	9604	26.72	4110.2	1763.9	2131.3	5.93	1924.5	5.36	952.3	2.65	314	.87	264.3	.73	97.2	.27	18	.05	172.5	.48	5874.1	16.35	527	1.46	333	.92	105	.29	965	2.68	6839.1	19.03	2764.9	7.69

3. The "balance of nature" appears to be set in favor of *Pissodes* in that about 50 per cent of the mature weevil larvae, or an average of about six per leader, successfully emerge while the parasites are responsible for only about half the number of mature larvae which do not emerge, or only about three weevils per leader or less.

It may be well at this point to compare these conclusions with what Peirson (1922), Graham (1926), and MacAloney (1926) have said in regard to the parasites of *Pissodes.* Peirson, who bred out some parasites, wrote:

> "It has proved a revelation to note the high percentage of parasitism in connection with the white-pine weevil. . . . It is during the pupation stage that the heaviest percentage of parasitism takes place. It is probable that nearly fifty per cent of the pupae are devoured by parasites."

In general, the optimum time for parasitization by all parasites, except *Lonchaea* which oviposits over the weevil eggs or in its feeding punctures, was found, in this study, to be when the weevil larvae were mature and just starting the construction of their pupal cells. Graham's statement follows:

> "In the vicinity of Ithaca, *Eurytoma pissodis* Gir. is by far the most important parasite of the weevil. In several pine clumps the weevils were found to be parasitized to the extent of 50 per cent. A similar degree of parasitism seems to hold consistently wherever the white-pine weevil is abundant.
>
> "The most important predacious insect that has been observed in this study is the larva of a fly which is not ordinarily considered as predacious, *Lonchaea rufatarsus.*"

Certain observations made upon *Eurytoma* by Graham will be discussed under its biology in section B II of this paper. MacAloney says:

> "We have collected or bred from weeviled leaders, parasites and predators, but not all of these are numerous. Four or five offer considerable promise if they could be bred and liberated in large numbers, but at this time that is impossible. The two most important, *Eurytoma pissodis* Girault and *Lonchaea laticornis* Mg. are external feeders."

The ranking of the parasites studied corroborates Graham and MacAloney on the relative importance of *Eurytoma* and *Lonchaea* (and it is assumed as very probable that the *Lonchaea* in each case is the species *corticis.* The rank of the parasites is herewith summarized from Table 12. Though there is a differential effectiveness on the part of the parasites, since some species do not consume the host gregariously and others do, the relative abundance of the eight primaries obtained was such that the following arrangement would hold for either basis, abundance or effectiveness.

TABLE 13
The Rank of the Primary Parasites of *Pissodes strobi*

Rank	In Massachusetts		In nine other states		In all material	
1	*Eurytoma pissodis*	5.53	*Lonchaea*	23.86	*Eurytoma*	5.93
2	*Microbracon pini*	2.80	*Eurytoma*	8.68	*Lonchaea*	5.36
3	*Lonchaea corticis*	2.65	*Microbracon*	1.59	*Microbracon*	2.65
4	*Eupelmus pini*	.99	*Rhopalicus*	.95	*Eupelmus*	.87
5	*Rhopalicus pulchripennis*	.70	*Coeloides*	.71	*Rhopalicus*	.73
6	*Coeloides pissodis*	.26	*Calliephialtes*	.13	*Coeloides*	.27
7	*Calliephialtes nubilipennis*	.04	*Eupelmus*	.04	*Calliephialtes*	.05
8	*Spathius* sp.				*Spathius* sp.	

The figures in the above table refer to the percentage of effectiveness in the given class and may well serve as indices of relative importance.

II. The Several Parasites

Introduction

This section deals with:

1. The biologies of the insect parasites of *Pissodes strobi*, in order of importance, in so far as these biologies were determined.
2. A list of parasites reported by other investigators but not obtained in the course of this study.
3. A list of other parasites obtained in this study which are *not* parasitic upon the weevil so far as is known.
4. A brief discussion of the insect predators obtained.
5. A brief discussion of the nematodes found associated with *Pissodes*.

It may not be amiss at this point to state that the word, "parasites," has been used throughout this paper because of its general acceptance. "Parasitoids," suggested by Reuter in 1913, is, perhaps, more accurate since, by definition, a true parasite does not feed so extensively upon its host that it destroys it. Kennedy[27] prefers the first term and considers that, in the forms where the host is killed and only the larvae are parasitic, they are nevertheless true parasites. He says:

> ". . . It is the form of parasitism necessarily evolved from a parasite with complete metamorphosis, which parasite takes advantage of all the specializations of complete metamorphosis for its success. These specializations are a larva adapted to internal parasitism and an active winged adult with highly developed eyes (Pipunculidae) or organs of smell for finding new hosts each generation. Complete metamorphosis has permitted the use of small hosts (accommodating one parasite only) and a new host for each generation of the parasite."

It is also difficult, upon occasion, to distinguish between "parasite" or "parasitoid" and "predator." Wheeler[28] describes parasitoidism as a refinement of predatism and the term predatism may then be used to include a *rapid* destruction of the prey, a lesser degree of specialization in oviposition, adaptations to the host, and the like. Graham[29] says:

> "The chief distinction, in entomological usage, between them (parasite and predator) is that a parasite obtains its food from a single organism of another species, the host; whereas the predator feeds upon a series of victims, the prey."

[27] In a seminar outline at Ohio State University, 1926.

[28] Wheeler, W. M. 1926. Les Sociétés d'Insectes, p. 35.

[29] Graham, S. A. 1929. Principles of Forest Entomology, pp. 54–55.

In this paper, all of the insects termed parasites are—in their larval stages—external feeders upon *Pissodes,* which they consume more or less rapidly, and seek their host—in the adult stage—with varying degrees of efficiency.

1. The biologies of the parasites

Eurytoma pissodis

Introduction

This chalcidoid, family Eurytomidae, is, without doubt, the chief primary parasite of the white-pine weevil since it ranks first in both abundance and effectiveness wherever a large sample of weeviled leaders are examined; it exhibits, moreover, a high degree of specialization for its rôle. At present no other hosts are known and no other host of this species may exist.

History

Eurytoma pissodis was first noted by Graham (1926) who found it in the pupal cells of *Pissodes* at Taylor's Falls, Minn., in September, 1916; specimens were sent to Girault (1917) who named and described the species from two males and seven females. Because of its abundance, this parasite has been noted by other investigators, including Britton (1920A), who lists the species as obtained in 1912 from Rainbow, Conn., and MacAloney (1926); Houser (1918) and Peirson (1922) both reared a *Eurytoma* sp. in Ohio and in Massachusetts, respectively, which may have been *E. pissodis.*

Distribution

This parasite is apparently well distributed over the entire range of its host as may be shown by the following records:

Table 14
Distribution of *Eurytoma pissodis* Gir.

Locality	Investigator	Date
Maine—		
Alfred	MacAloney	?
Bar Mills	MacAloney	?
Burnham	Taylor	1928—July
China	Taylor	1928—July
Greene	Barnes	1926—May
Readfield	Taylor	1928—July
Sidney	Taylor	1928—July
New Hampshire—		
Concord	Taylor	1928—July
Durham	Taylor	1928—July
Lebanon	Barnes	1926—May
Oxford	Barnes	1926—May

TABLE 14—(*Continued*)
Distribution of *Eurytoma pissodis* Gir.

Locality	Investigator	Date
Vermont—		
Bradford	Taylor	1928—July
Fairlee	Taylor	1928—July
Norwich	Taylor	1928—July
Massachusetts—		
Boston	Taylor	1926–28—May–August
Bridgewater	Barnes	1926—April
Brookline	Taylor	1928—June
Dedham	Taylor	1927—May
Franklin Co.	Barnes	1926—May
Milton	Taylor	1926–28—May–July
North Beverly	Taylor	1928—June
Petersham	Taylor	1927—July
Plymouth Co.	Barnes	1926—May
Rhode Island—		
East Greenwich	Taylor	1928—July
Connecticut—		
"Northwest part"	Taylor	1928—July
Rainbow	Britton	1912
New York—		
Benedicts	Barnes	1925—August
Berlin	Barnes	1926—June
Cambridge	Barnes	1926—May
Canaan	Barnes	1925—August
Griswold Mills	Barnes	1925—July
Hudson	Barnes	1927—May
Ithaca	Barnes	1925–26—May, June
Johnstown	Barnes	1926—August
Lewis	Barnes	1926—May
Lowville	Barnes	1925—August
Oneonta	Taylor	1928—July
Providence	Barnes	1925—August
Warrensburg	Barnes	1927—May
Pennsylvania—		
Ansonia	Taylor	1928—July
Fayetteville	Taylor	1928—July
McConnellsburg	Taylor	1928—July
Milroy	Taylor	1928—July
Mont Alto	Taylor	1928—July
Renovo	Taylor	1928—July
Sizerville	Taylor	1928—July
New Jersey—		
Morris Co.*	Taylor	1928
Virginia—		
Boyce*	Taylor	1928
Ohio—		
Mentor	Taylor	1928—June, July
Michigan—		
Ann Arbor	Taylor	1928—July
Roscommon	Taylor	1928—June, July
Minnesota—		
Taylor's Falls	Graham	1916

* Identified from larvae or prepupae in the pupal cells of *Pissodes.*

Description

Adult. The general color is black, dull on the sculptured thorax but glossy on the polished abdomen; the bright red eyes are conspicuous. The size range for the females is about 4.4 × 1.2 to 5.5 × 1.3 mm.; for the males, 2.8 × .7 to 4.3 × 1.2 mm. Girault's description follows:

"*Eurytoma pissodis* n. sp.—Female: Exactly similar to the type of *cleri* Ashm., except as follows: all the coxae are black, the hind femur is black (usually) laterad and along the dorsal edge at distal half, the hind tibia black except at each end; the tegulae are black; the abdomen is entirely black; the stigmal vein is barely shorter than the post marginal, the median basin of the propodeum bears fine cross-rugae which are continuous (not so in the other but variable in both); the ventral half of the prepectus is not rugulose but near caudal margin has a cross-row of foveae; the middle section or finely punctate portion of the mesopleurum is larger (a third wider), as wide as the third or caudal or the section with cross-rugae; the propodeum and prepectus are wholly black; and the abdomen from above is finely scaly after segment 2 (not until after 4 in the other). A variety has black spots above on the first two pairs of femora, the cephalic tibiae are black centrally dorsad, the middle tibiae wholly black.

"The male is similar except that the scape is black. Petiole twice longer than wide; funicle 5-jointed."

Egg. The egg is a cylindrical ellipsoid with both ends tapering to a stalk, one of which is longer than the other. The two eggs noted were yellowish but appeared darkish because of a very fine black pubescence; they measured about .51 × .18 mm., exclusive of the stalks.

Larva. The cream or ivory-colored, footless larva shows no unusual characters. Representative larvae at different stages[30] measured 2.28 × .9, 3.18 × .9, 4.62 × 1.44, and 6. × 1.5 mm.

Prepupa. The inactive prepupa, typically, is whiter than the earlier stage larvae. A small series ranged about from 4.5 to 6 mm. in length and from 1.4 to 1.6 mm. in width.

Pupa. The pupa is cream colored and measures much the same as the adult.

Life Cycle

Eurytoma pissodis emerges shortly before the optimum time for parasitization of *Pissodes*; this may be from mid-May to late June

[30] It was impossible, unfortunately, to determine all the larval instars with certitude because of the extreme difficulty in obtaining eggs from this species and the resultant paucity of young larval material.

or from mid-June to late July, depending upon the development of the season. Graham (1926) states that "The whereabouts of this parasite during May and June is unknown. Perhaps another generation develops on an alternate host." The observations made in this study definitely eliminate the possibility of any alternate host at this time. It is striking, indeed, that, of all the parasites of the white pine weevil observed, *Eurytoma* emerges the closest to, and often virtually at, the optimum time to parasitize its host. This is when the weevil larvae are mature and when there is no appreciable interval in which other hosts could be sought for the production of an alternate generation. *Eurytoma* may be said to be well adjusted to the phenology of its host, *Pissodes*. The males precede the females by several weeks, the emergence data for the species are given in Table 15.

TABLE 15

Spring Emergence of *Eurytoma pissodis* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
June 13	1	0	June 25	3	0	July 7	45	23	July 19	0	42
14	1	0	26	2	0	8	56	53	20	0	6
15	3	0	27	2	0	9	48	77	21	0	8
16	2	0	28	6	0	10	27	78	22	0	3
17	6	0	29	3	0	11	22	145	23	0	14
18	5	0	30	23	0	12	9	263	24	0	9
19	0	0	July 1	41	0	13	6	148	25	0	6
20	0	0	2	85	2	14	1	89	26	0	0
21	2	0	3	68	5	15	1	114	27	0	0
22	0	0	4	132	14	16	0	100	28	0	4
23	0	0	5	67	19	17	0	63			
24	0	0	6	18	5	18	0	48	Totals	685	1336

Copulation takes place after a brief courtship and oviposition apparently a few days later. Possibly the eggs remain attached to the host larva for about a week, though probably not longer, before they hatch. In the cases noted, the host was consumed in six to seventeen days with a mean of about ten days. It is common at first for the young parasite larva to double its size in two or three days. When the host is entirely consumed, the prepupa becomes quiescent and remains in the pupal cell of the weevil until the following spring. It is estimated, from forced cultures, that the pupal stage requires about one week in nature; pupation occurs in May or June. The adult bores directly outward through the xylem of the weeviled leader (the exit hole measures about 1.3 mm.) and the life cycle is complete. Based upon the small number that were found stuck, the emergence percentage is about 99 per cent. It is apparent from the above that most of the parasites are thus in the prepupa stage for over ten months. A small number of the *Eurytoma* larvae, however, about four per cent of the total number, may complete their development the same summer and emerge as adults in August. It is clear that these summer emergents would have great difficulty in parasitizing *Pissodes* at this time since the host is in the late pupal or adult condition. Unless *Eurytoma* finds another host in a stage favorable for parasitism in August, no small second generation is likely to occur. It is suggested as very probable that these summer emergents do not reproduce themselves.

The longevity of this parasite in the adult stage does not need to be great since the host is so near the optimum stage for parasitization. Newly emerged adults kept at room temperature without food were found to have a range of longevity of five to nine days; the data for the longevity of some of the forced forms, kept at room temperature and fed with honey and water as described previously, are as follows:

Table 16

Longevity of *Eurytoma pissodis*

Males					Females				
No.	Date emerged	Date died	Age in days	Total	No.	Date emerged	Date died	Age in days	Total
1	4/4	4/21	17	17	1	3/18	3/28	10	10
3	4/8	4/18	10	30	1	4/8	4/21	13	13
1	4/9	4/23	14	14	1	4/15	5/16	31	31
1	4/13	5/2	19	19	3	4/16	5/16	30	90
1	4/15	4/23	8	8	3	4/21	5/16	25	75
2	4/21	5/16	25	50	1	4/23	5/23	30	30
Average longevity: 15.33 days.					1	4/27	5/31	34	34
					1	4/30	5/20	20	20
					1	4/30	5/23	23	23
					Average longevity: 25.07 days.				

It may be noted that the females lived almost twice as long as did the males under identical conditions.

Habits

Courtship. Of the several parasites studied, *Eurytoma* alone employed courtship tactics; this is consistent with the general statement[31] of Pierce and Cushman that many chalcidoids always have a courtship while other parasites, with a stronger sex attraction, mate immediately or without preliminary maneuvers. In *Eurytoma,* as is usual, the sex attraction is more strongly developed in the male and the essentials of the courtship are attempts to stimulate the apathetic female. Based upon numerous observations, the male leaps upon the dorsum of the female and stands there; his vibrating antennae are touched to her quiescent ones as she walks about. After five minutes more or less, if the female hesitates in her walking, the male suddenly swings the tip of his abdomen well forward under the venter of her abdomen. If she moves restlessly the antennal osculations are resumed. Usually, after one or more trials, actual mating is accomplished. In this event, the abdomen of the male is very considerably curved around the apex of the female's abdomen and extended forward to the genitalia. Insemination was not timed but it is an act which requires but a few seconds. Courtship and copulation occur immediately upon emergence.

Some interesting acts, which appear to be manifestations of the courtship instinct, were noted. In one case, three individuals remained in the courtship position for several minutes, the lowermost was a female, the other two were males. Several instances were observed where one male would assume the copulatory position or attempt to woo another male. These occurrences took place in a shell vial in which there were 4 females and 26 males and it seems quite possible that the males were so stimulated by the presence of the females that temporary errors in sex identification were made.

Oviposition. The maneuvers and attitudes preliminary to oviposition were readily observed but the actual deposition of eggs was extremely rare. Based upon numerous observations, the procedure was as follows: The female walks along the weeviled leader deliberately with her antennae slowly moving. Abruptly, she pauses and, by arching the abdomen, places the tip of the ovipositor sheath at a point on the bark; the ovipositor is inserted at this point and the sheath is removed at once by the straightening out of the

[31] Pierce, W. D. and Cushman, R. A. 1915. A few notes on the habits of parasitic Hymenoptera. Proc. Ent. Soc. Wash. 17: 164–167.

abdomen. This act will be clearly understood when it is recalled that the ovipositor emerges from very near the anterior end of the abdomen (more or less typical of all chalcidoids), while the ovipositor sheath lies in a groove along the venter of the abdomen. The ovipositor acts as one piece as it is moved up and down by movements of the entire abdomen.

A disposition on the part of the female to utilize breaks in the bark, lenticels, and the like, for explorations with the ovipositor was noted. A number of short trials interspersed with periods of prolonged drilling was the rule: a typical case included five trials and two periods of drilling, all at different sites; this total series of acts consumed about 22 minutes. A female may keep up such maneuvers for an hour or more.

The exact details of oviposition proper are not definitely settled. Graham (1926) says "The eggs were not observed, but apparently they are deposited in the pupal cells of the weevil since the larvae feed externally upon their host and have been found only in these cells." The observations made in this study quite corroborate Graham that the parasite is found only in the pupal cells of the host. It may then be inferred that the weevil larva or pupa is parasitized while in the cells. If this is the case, this would require that the slender ovipositor be thrust down into the cell either directly through the wood or through the entrance shaft, which may be more or less vertical and would not offer appreciable resistance in spite of wadded wood chips. In this study it was found that this inference is supported by the almost complete restriction of *Eurytoma* to the more slender leaders, those which measure not more than three-eighths of an inch in diameter, and usually less. In such slender leaders almost all of the pupal cells are in the pith or are of the Type One class. Theoretically, at least, these cells are not inaccessible. The thickness of the wood between the pupal cell and the bark in such leaders ranges from 1.5 to 3.5 mm.; in specific terms, to reach a pupal chamber at the center of a leader 8 mm. in diameter and to touch the weevil larva or pupa within would require an ovipositor with a minimum length of about 3.5 mm. To check this point, a number of *Eurytoma* ovipositors were measured and were found to average about 4.3 mm. in effective length (from tip to where accessory members are attached at the ventral anterior portion of the abdomen). It is clear that, if inserted their full length as was observed to occur, the ovipositors are amply long enough to parasitize *Pissodes* in the manner suggested above.

This inference is further supported by the location of the two eggs found in the oviposition cages in the course of this study. In both cases, the egg was found attached to a weevil larva in a recently completed pupal cell.

An alternative supposition might be that the egg is attached to a weevil larva while it is just under the bark and about to burrow in and construct a chamber at the center of the leader. This would necessarily imply that the larva is not seriously paralyzed or killed, that the egg is so well affixed that it is not dislodged as the host larva mines through the xylem, while no satisfactory explanation of why the parasite is virtually confined to the innermost pupal cells can then be found.

In view of the above, it seems much more reasonable to assume that *Eurytoma* does oviposit upon weevil larvae and pupae within their cells, either through the wood or, more probably, through the entrance shafts.

Graham (1918) states that he never found living *Pissodes* larvae with *Eurytoma* larvae and he infers from this that the weevil grub may be stung to death before oviposition, as was found to be the case with *Dibrachys clisiocampae* (Fitch), a parasite which stings its host, *Galleria mellonella,* repeatedly and returns later to oviposit upon it. No definite evidence concerning this point was obtained in this study. The two Eurytoma eggs found were taken from larvae which were not dead at the time of their isolation in the life-history cell slides; the inactivity of these larvae, at this time, did not seem different from that of other quiescent larvae in the initial stages of transformation to pupae. Unfortunately, these two weevil larvae were among those which, at the daily inspection, appeared to be in good condition until, a week later, they were found dead and the cultures contaminated with an early stage of a mold.

Larvae removed from *Eurytoma* oviposition cages did not show any punctures, though this proves nothing since larvae pricked with a fine insect pin, approximately the thickness of the *Eurytoma* ovipositor, likewise showed no punctures. One pupa, with no parasite egg but with five black spots was found; this might be interpreted as five ovipositor punctures and subsequent bacterial infection. On the whole, however, there seems no particular justification for inferring that *Eurytoma* has the habits of a parasite which belongs to another family. The primary consideration here is whether *Eurytoma* stings its host at all; this has not been definitely ascertained.

But one egg is laid per host; in hundreds of weevil pupal cells, never more than one parasite per host was observed. Since the females are very loath to lay eggs in captivity, it is difficult to estimate a figure for the total number of eggs that may be laid per female. Removal and dissection of the ovaries of 20 females yielded ova counts of five to seven nearly mature eggs in six cases; these ova measured about .74 x .22 mm. This would seem to indicate that a maximum of about six eggs may be laid in a day. The largest number of immature ova that was counted was 31, but because of the obvious difficulties attendant to the counting, the true number may be greater.

Parasites placed with uncovered weevil larvae removed from the leaders would not oviposit upon them or molest them in any way.

Other habits. Both sexes eat honey and water avidly. The adults are "nervous fliers" in that they are easily alarmed and more quick to take wing than the other parasites studied. *Eurytoma* appears to be somewhat less positively phototropic and more negatively geotropic than some of the other parasites studied, but there was no opportunity to develop these points by experimentation.

Effectiveness

Because of its greater abundance, its habit of but one larva per host, and its general high degree of efficiency, *Eurytoma pissodis* is the most effective of the parasites of the white pine weevil. In this study, it was found to account for 2136, or about six per cent of the available mature weevil larvae in 3009 weeviled leaders. Its effectiveness in detail will be found in Table 12.

A striking feature about *Eurytoma* is its comparative specialization. Though it forms no cocoon (as is typical of the chalcidoids) and passes from ten to eleven months of the year as a naked prepupa in the pupal cell of its host, and is particularly vulnerable, under laboratory conditions, to the mite, *Pediculoides ventricosus,* yet it is a flourishing parasite. That it maintains its numbers in the field would seem largely due to the ability to parasitize its host in the innermost or Type One pupal cells, where it is relatively immune to bird attack and reasonably secure from molestation by the arthropod predators at the periphery of the leader. The parasite consumes its host quickly and thoroughly and the not-too-moist, clean wood chamber in which the prepupa lives for so long a time, apparently does not foster bacteria or fungi. *Eurytoma* may thus be considered highly adapted to its host on the following counts:

1. The peak of emergence of the females is very close to the optimum time for parasitization of the mature weevil larvae in their pupal cells, and their longevity is such that they may oviposit for about a month.
2. A definite courtship is practiced.
3. The eggs possess attachment stalks.
4. But one egg is laid per host.
5. Security is afforded the prepupae by the Type One weevil pupal cells which the length of the ovipositor of the adults is adapted to reach.

Lonchaea corticis

Introduction

This fly, a member of a family, Lonchaeidae, which is usually not considered either parasitic or predacious, though there are several European species with habits of such a nature, was a close second in abundance and effectiveness in the total material and was easily first in most of the small lots of weeviled leaders from states other than Massachusetts. Though it is facultatively parasitic and is often heavily parasitized by a small chalcidoid, it well deserves its rank in importance as a primary parasite of *Pissodes strobi.* It is classified here as a ''parasite'' because it shows a much closer adaptation to the phenology of its host than does a typical ''predator'' to its prey; indeed, because of its oviposition habits, it is probable that *Lonchaea* is dependent upon Pissodes or a similar host for its existence.

History

Lonchaea corticis was established as a new species in the course of this study and was described (Taylor, 1928) from types taken from an extensive series. The holotype, a male, and allotype emerged June 1, 1928, from white pine leaders collected on the Stony Brook tract. A dipteron of this genus has been obtained in abundance by several recent workers on *Pissodes strobi, viz.,* Graham (1926), who determined the fly obtained by him as *L. rufatarsus* (*i.e., L. rufitarsis* Macq.), now considered a synonym of *L. polita* Say; MacAloney (1926), whose species was determined for him as *L. laticornis* Mg.; and Barnes, in whose case the fly was determined for him by Aldrich as a new species. One of Barnes specimens, when compared with the types of *corticis,* was found to be identical with *corticis*. It is regarded as highly probable that the *rufitarsis* of Graham's and the *laticornis* of MacAloney's are also identical with the species herein treated. *Lonchaea corticis*, while very close to *laticornis*, has been determined by Malloch[32] as "probably a new species" and careful comparison with the holotype of *laticornis*, made at the time the description was prepared, showed separating characters.

Distribution

This parasitic fly is widely distributed over the entire range of its host; the distribution data are as follows:

TABLE 17
Distribution of *Lonchaea corticis* Taylor

Locality	Investigator	Date
Maine—		
Burnham	Taylor	1928—June, July
China	Taylor	1928—June, July
Readfield	Taylor	1928—May–July
Sidney	Taylor	1928—June
New Hampshire—		
Concord	Taylor	1928—May, June
Durham	Taylor	1928—May–July
Epping	Plummer	1927–28—May
Madbury	Plummer	1927–28—May
Portsmouth	Plummer	1927–28—May
Vermont—		
Bradford	Taylor	1928—May, June
Fairlee	Taylor	1928—May, June
Norwich	Taylor	1928—May, June
Massachusetts—		
Boston	Taylor	1926–28—May–August
Brookline	Taylor	1928—May, June
Dedham	Taylor	1927—May, June
Middleboro	Barnes	1926—April
Milton	Taylor	1926–28—May–August
North Beverly	Taylor	1926—June
Petersham	Taylor	1927—June
Rhode Island—		
East Greenwich	Taylor	1928—June, July
Connecticut—		
"Northwest part"	Taylor	1928—June

[32] A personal communication. 1928.

Table 17—(*Continued*)
Distribution of *Lonchaea corticis* Taylor

Locality	Investigator	Date
New York—		
Ithaca	Barnes	1925–27—May–August
Lowville	Barnes	1927—July
Oneonta	Taylor	1928—May, June
Stanfordville	Barnes	1926—July
Watson	Barnes	1926—July
Wilmington	Barnes	1926—July
Pennsylvania—		
Ansonia	Taylor	1928—May, June
Blain	Taylor	1928—May
Fayetteville	Taylor	1928—May, June
McConnellsburg	Taylor	1928—May
Mifflinburg	Taylor	1928—May, June
Milroy	Taylor	1928—May, June
Mont Alto	Taylor	1928—May
Renovo	Taylor	1928—May
Sizerville	Taylor	1928—May, June
Maryland—		
Garrett Co.*	Taylor	1928
Michigan—		
Ann Arbor	Taylor	1928—May
Roscommon	Taylor	1928—May, June

* Identified from larvae in the weeviled leaders.

Description

Adult. In general color, the dark steel-blue of the thorax and abdomen may vary to a dark blue-black; the shape of the abdomen may be elongate, oval, or almost round, and its tip may be blunt though usually it is broadly tapered. The fine hairs between the apical pair of scutellar bristles may be one or more, usually two or four; the scutellar bristles themselves may be asymmetrical or, rarely, apparently reduced to but one bristle. The region at the base of the scutellum (postscutellum?) may show a ferruginous band of varying width but this band does not include the whole sclerite as in *L. laticornis.* There is no appreciable disparity in size between the sexes; the size range is about 3.5 to 4 mm. The published description is reproduced:

Male. Length, exclusive of wings, 3.8 mm. (In allotype, length, exclusive of wings and ovipositor, 3.9 mm.)

Head dull black; frons dull black, without large irregular pits or a transverse depression; interfrontalia with a number of black, incurved hairs with no definite arrangement. Frons wide, about one-half as wide anteriorly as its length (in female, wider, almost as wide as long); upper frontal orbits blue-black, glossy, not microscopically strigose; ocellar region bronze-black. Frontal lunule bears several dark hairs. Face greyish, pruinose; oral margin produced into a ridge. Cheeks without strong bristles, anteriorly fringed with uniform dark hairs. Antennae dark brown at base to reddish brown, greyish or yellowish pruinose; the third segment reddish brown at base, dark brown on outer side, lighter brown on inside; third segment a little less than twice as long as its greatest width; arista regularly and very finely serrate with minute, uniformly short, apically pointing hairs.

Thorax and abdomen a dark steel-blue; pteropleura bare; no hairs near the stigmatal bristle; scutellum greenish or bluish to bronze-black, margin fringed with a number of small black hairs; several fine hairs present between the apical pair of scutellar bristles, or just posterior to a line connecting these two bristles. Region at the base of the scutellum unicolorously a dark blue-black and not entirely ferruginous. Metanotum unicolorously dark blue-black, dull or pruinose for one-third to one-half of its width. Thoracic hair, in general, no longer than the abdominal hair.

Legs black; metatarsus, second and third tarsal joints light yellow, last two segments brownish-black; whole tarsus covered with stiff, short, minute black hairs.

Wings iridescent; nervures light brown. Squamae pale yellowish-white, with light yellowish-brown border and pale yellow fringe. Halteres black or nearly so.

Egg. The egg is elongate, pointed at one end and rounded at the other, more or less slightly curved, pearly white, and appears to be finely striated. A series of eggs averaged about .72 x .18 mm. Superficially, they resemble the eggs of *Microbracon pini* but they are whiter; their position in the leader and their arrangement in clusters of up-ended eggs make them easily distinguishable from the braconid's eggs.

Larva. The larva is a typical maggot of the unmodified muscoid Diptera; it is whitish to yellowish cream, footless, with black mouth hooks at the tapered anterior end and dark brown, slightly protruding spiracles at the large, blunt posterior end. A series of larvae at representative stages of development measured .7 x .15, 2 x .3, 3.1 x .45, and 6.6 x .9 mm. respectively.

Puparium. The puparium is relatively elongate though shorter than the maggot, and brown in color; the ridges formed by the shrinkage in the dried larval skin are closer together at the posterior end; the mouth-hooks and spiracles are readily visible. The puparium measures about 4 x 1.2 mm.

Life Cycle

Lonchaea corticis, in the spring, emerges from early May to mid-July, but the peak of its emergence closely corresponds to the heighth of the oviposition period of the white-pine weevil. The males precede the females by two to four weeks; in 1928, one month after the spring emergence had commenced, about 80 per cent of the total number were males, whereas two months later, the males were but about 55 per cent of the total. The spring emergence data for the species are given in Table 18:

TABLE 18

Spring Emergence of *Lonchaea corticis* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
May 8	1	0	May 26	0	0	June 13	6	65	July 1	0	0
9	0	0	27	20	1	14	1	60	2	0	1
10	1	0	28	11	0	15	2	25	3	0	1
11	0	0	29	48	0	16	2	21	4	0	2
12	2	0	30	69	0	17	1	7	5	0	0
13	1	0	31	155	0	18	3	9	6	0	0
14	1	0	June 1	117	2	19	2	0	7	0	0
15	3	0	2	105	2	20	0	0	8	0	0
16	9	0	3	104	16	21	2	3	9	0	1
17	7	0	4	26	54	22	1	0	10	0	0
18	0	0	5	2	5	23	0	2	11	0	1
19	0	0	6	1	0	24	1	7	12	0	0
20	0	0	7	40	91	25	0	14	13	0	0
21	4	0	8	36	42	26	1	5	14	0	0
22	7	0	9	14	23	27	0	1	15	0	0
23	0	0	10	18	64	28	0	3	16	0	0
24	1	0	11	27	71	29	0	1	17	0	1
25	18	1	12	20	94	30	0	7	Totals	890	703

No success in getting Lonchaea to copulate or to oviposit in captivity was achieved.[33] Much of the data in regard to the life history is, therefore, based upon field observations and the results of dissection of the leaders. From 6 to 25 eggs, pointed end up, have been counted in the characteristic clusters in the feeding and oviposition punctures made in the leaders by *Pissodes*; often, dipter-

[33] C. C. Plummer in a personal communication reported the same inability.

ous eggs are laid upon the weevil eggs. Since the eggs of *Lonchaea* were never found in any other site, the interesting point, whether *Lonchaea* would oviposit without the precedence of *Pissodes,* arises. In the oviposition cages, even when punctured leaders were available, the fly would not deposit eggs. With a consideration of the usual specificity of the egg-laying habit and of the above, it would seem that *Lonchaea* is probably dependent upon *Pissodes strobi* (or some similar bark-puncturer) for its continued existence; at least, it may be said that the life history of the fly is intimately connected with that of the weevil. It is clear that *Lonchaea* oviposition occurs after weevil oviposition and that, in both cases, the oviposition period ranges over a month or more.

It is presumed that the eggs of *Lonchaea* require about the same time to hatch as do those of *Pissodes* for the maggots usually follow the weevil larvae down the leaders. If the eggs, which split partway down their length, hatch simultaneously with the weevil eggs, the dipterous larvae and grubs mine the shoot virtually side by side. In this event, the fly larvae consume many young weevil larvae as well as frass; it should be remembered, however, that about 80 to 90 per cent of these young weevil larvae would have starved anyway. If the fly eggs hatch considerably later than do those of *Pissodes,* the maggots may never catch up with *Pissodes* until the latter have begun to pupate. In this case, *Lonchaea* feeds largely upon frass and those stragglers among the weevil larvae which would have died anyway, and, when at last it catches up with *Pissodes,* the latter is in pupal cells, the entrance burrows of which are more or less plugged with wood chips; under these conditions, there is a minimum of effective parasitism. If, however, *Lonchaea* hatches only a few days to a week later than *Pissodes,* the dipterous larvae catch up with the weevil larvae at about the time the weevil ring is disintegrating. When this occurs, a number of mature weevil larvae are destroyed; furthermore, under these conditions, the maggots are able to invade many pupal cells before they are quite finished or the entrance shafts too densely packed with wood chips, so that mature weevil larvae are consumed in their cells as well. In this last event, effective parasitism reaches a maximum and cases have been noted, when *Lonchaea* was abundant and had hatched at the optimum time, where every weevil larva in the leader was consumed.

An interesting feature of the life history is that the fly larva feeds on both weevil frass and weevil larvae, and it has been shown by laboratory tests to be able to subsist and finish its development upon an exclusive diet of either. The length of time spent in reaching maturity seems to be directly proportional to the amount of weevil proteins consumed. The August emergents of this species, about 57 per cent of the total emergents, from the laboratory experiments, are concluded to be those individuals which consumed more weevils and less frass. The maggots which have not fed upon as many grubs do not emerge from their puparia in August or September but overwinter as pupae or, not infrequently, as larvae. The summer emergents cannot oviposit in weeviled leaders at such a time unless the exit holes of the adult weevils are utilized. No indications of this were noted and, since there are no immature forms of Pissodes available in August, it is very probable that the summer emergents of Lonchaea do not reproduce themselves or else are obliged to find other hosts. The latter possibility is by no means remote if the observations of other workers are considered. Barnes observed a female of *Lonchaea corticis* ovipositing in the galleries of the bark beetle, *Pityogenes hopkinsi* Swaine in August and also reports the discovery of puparia at the ends of the larval tunnels of the beetle. In Europe, Kleine (1907) found *L. vaginalis* Fall. breeding in the galleries of the cambium beetle, *Myelophilus piniperda,* in *Pinus sylvestris*; Makrzeckii (1923) reports *L. laticornis* Mg. feeding on frozen young bark beetles, *Ips typographus,* and also developing in their galleries.

The longevity of the flies is noteworthy. Almost all of the newly emerged individuals had shrunken abdomens yet, without food and at room temperature, they frequently lived two weeks or more. When supplied with honey and water, a tendency to gorge was noted. Longevity in this event was less than when overeating was prevented by a scanty food supply and flies fed with moderate amounts of honey and water, at room temperature, lived as long as a month. Some flies were kept in the ice-chest but their longevity barely exceeded that of those kept at room temperature. The longevity of the sexes was approximately equal under these conditions.

Habits

Copulation and oviposition. Neither mating nor oviposition were observed either in the field or in the laboratory. It may be inferred from the clusters of eggs found in the punctures made by Pissodes that the female Lonchaea seeks out these punctures and with her soft segmented ovipositor places a number of eggs, with their long axes perpendicular to the long axis of the leader, tightly within these punctures.

Larval feeding habits. The feeding habits of the fly larvae were made the subject of special consideration. It was at first supposed that the larvae were primarily frass-feeders and that dead or feeble weevil larvae were consumed more or less incidentally. Further study, however, led to the conclusion that the weevil larvae are sought and are consumed in preference to frass. There can be no question concerning the attack of healthy, mature weevil larvae by the maggots, and even weevil pupae in their cells are not exempt.

On July 1, young *Lonchaea* maggots, all similar in size, were confined in watch glasses with (a) damp frass alone, with (b) weevil larvae alone, and with (c) both frass and grubs. Larvae fed on damp frass exclusively developed slowly and did not form puparia until mid-September; larvae fed on weevil larvae exclusively attained full size in ten days, ceased feeding and formed puparia in late July and early August. The results of the mixed-food cultures, while perhaps not entirely conclusive, strongly indicated that the maggots preferred weevil larvae to frass. The fly larvae in these cultures, because of their differential diet, were soon uneven in size; after fresh frass and more weevil larvae were added, the net results were that about 70 per cent of the fly larvae reached maturity by early August, while the remaining 30 per cent (since no more weevil larvae were available so late in the season) were still larvae in late August, shortly after which time some died and some formed puparia. In none of these experiments, did the maggots molest the weevil larvae in less than 24 hours while often two or three days would elapse before the grubs were attacked. Usually, more than one dipterous larva observed to feed upon a weevil grub; the range under the bark was from 2 to 14, and in the pupal cells, from 1 to 10. Under such conditions of gregarious feeding, the weevil larva is eaten within a few hours and the maggots are ready to attack another. Graham (1926), who says "Usually several will attack one larva at the same time and will devour it quickly,' is corroborated.

Because the *Lonchaea* larvae are facultatively parasitic and because they are gregarious feeders, it was difficult to estimate:

1. The proportion of the fly larvae that attacks mature weevil larvae.
2. How many weevil larvae, or what fraction of a weevil larva, *each* maggot consumes on an average.

Based upon the assumption that the proportion of summer emergents to spring emergents is correlated with a predominantly larval and a predominantly frass diet, respectively, the number thus shown to have practiced effective parasitism would be about one half. Since so many of the puparia formed in mid-summer do not yield adults until the following spring, this assumption is not tenable. It was next decided to base estimates of *Lonchaea* effectiveness upon the premise that *all* the flies had consumed some part of a mature weevil larva, though it was realized that, in some cases this was probably not so, and that, in many other cases, only immature weevil larvae fated to starve anyway, were consumed. On this basis, however, at least the maximum *Lonchaea* parasitism could be determined.

A number of experiments were made with maggots and grubs in watch glasses to determine how many weevil larvae could be eaten by each maggot. It was found that in eight days, 20 out of 40 fly larvae had consumed 16 out of 80 grubs, and that this twenty, which had then reached full size, had ceased feeding. These mature fly larvae were removed as soon as they began to form puparia. The others eventually all shared in eating the weevil larvae, approximately at a rate of one host per parasite. This one-to-one ratio was thus established as the maximum average number of hosts that would be consumed per maggot.

A census of the fauna of 134 leaders from widely separated localities gave 3377 weevil larvae and 1478 Lonchaea larvae, or a ratio of about 25:11. When the probable fate of these 3377 weevil larvae is calculated from the percentages shown in Table 11, it is evident that, under natural conditions, *Lonchaea* larvae do not consume an average of one weevil larva apiece. In other words, the 1478 dipterous larvae in the 134 leaders would not have consumed about 1478 weevil larvae but, on the basis of Table 11, they could be expected, at most, to have consumed only about 26.72 per cent of the 3377 weevil larvae, or about 917, which is about three-fifths of a grub per maggot. Since the percentage of 26.72 applies to *all* the parasites and predators, the expectation of weevil consumption by *Lonchaea* alone would be still lower. If the temporary assumption that all the *Lonchaea* larvae consume some part of a mature weevil larva is reverted to and applied to the above figures, then the average fraction of three-fifths of a weevil larva per Maggot, or about 1.6 *Lonchaea* per whole weevil larva, may be used in estimates of *Lonchaea* effectiveness.

It was finally decided, however, that an average of all *Lonchaea* puparia found in weevil pupal cells might also be a satisfactory basis for the measurement of *Lonchaea* effectiveness in the control of *mature Pissodes* larvae. A total of 1347 *Lonchaea* puparia was found in 679 pupal cells: This gives the fractional part of a host consumed by each dipterous larva as close to one-half, or about 1.9 *Lonchaea* individuals per whole weevil larva. It may be noted that this figure is reasonably close to the figure 1.6 obtained above; both figures, 1.9 and 1.6 err on the side of too much credit to *Lonchaea* effectiveness.

Other habits. Both sexes eat honey and water and, as noted previously, show a tendency to gorge this food.[34] The flies are comparatively easy to handle since they cling to a camel's hair brush or may be jarred from one container to another readily.

Effectiveness

In abundance in the material studied, *Lonchaea corticis* was a close second in the total material and it was easily first in most of the small lots of material from states other than Massachusetts. Despite the time factor or how soon its eggs hatch after those of *Pissodes* and its occasional very heavy parasitism by *Pleurotropis* n. sp., *Lonchaea* is second in effectiveness. In this study, on a basis of 1.9 parasites per host, and when the more or less heavy summer emergence is computed and added in, this lonchaeid fly was found to account for 1924 or about five to six per cent of the available mature weevil larvae in the 3009 weeviled leaders considered; the figures for the 2602 Massachusetts leaders are 830 or about two to three per cent.

On the whole, *Lonchaea* is an important primary parasite of the white-pine weevil. In some localities it is so abundant that all other parasites are overshadowed; in some leaders not a single member of the weevil ring survives. In spite of parasitism by the tiny pteromalid mentioned and its vulnerability to birds in the cases of the large number of maggots or puparia found just under the thin bark, *Lonchaea* seems to be abundant every year.

Discussion of the effectiveness of this parasite is not complete without the raising of the question whether *Lonchaea* consumes forms other than *Pissodes* in the weeviled leaders, especially the hymenopterous parasites of the weevil. While there is no positive evidence to support such a speculation, it may be significant that shoots in which the fly is abundant are singularly deficient in the other parasitic species.

[34] It is believed that honey and water is, perhaps, not the best type of food for the fly but, unfortunately, no time was available for experimentation with other food; gorging was prevented by decreasing the amount of food provided. It is possible that the type of food that was supplied may have been a critical factor in the indisposition of the captive flies to copulate or to oviposit, though if this were the case, it would seem that the unfed *Lonchaea* individuals might reasonably have been expected to at least copulate sometime after emergence.

(*To be continued in Vol. X, No. 1, p. 1*)

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Index to vol. IX (n. s.) 1928–1929

Valid genera and species in Roman type; new genera and species in **bold face** type; synonyms in *italics;* † indicates animals other than insects; * indicates plants.

New species and other new forms in this index, 15.

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THE BIOLOGY OF THE WHITE PINE WEEVIL, PISSODES STROBI (PECK), AND A STUDY OF ITS INSECT PARASITES FROM AN ECONOMIC VIEWPOINT*

Raymond L. Taylor

(*Continued from Vol. IX, No. 4, p. 248*)

Microbracon pini

Introduction

This braconid is considered third in importance among the primary parasites of *Pissodes* on the bases of its abundance, which was third in the total material and second in Massachusetts alone, and the indications of a partial second generation. Its docility and consequent ease of manipulation are noteworthy, while its early emergence suggesting a change of hosts makes it a particularly interesting species.

History

Microbracon pini was first obtained by Muesebeck (1925) and was described and named by him from eight females and four males reared from *Pissodes strobi* at the Gipsy Moth Laboratory, Melrose Highlands, Mass. The type locality was Gardner, Mass., and that of the allotype, Saugus, Mass. This parasite has since been reported by several collectors, *e.g.*, C. W. Johnson (1927), MacAloney, and Barnes. Peirson (1922) obtained a *Microbracon* species at Petersham, Mass., which was very probably *M. pini* but Mueseback, who made the determination, had not revised the genus at that time.

Distribution

This parasite appears to be rather widely distributed over the entire range of its host, though it does not extend, perhaps, as far south as *Eurytoma pissodis*. It is particularly abundant in New England. The distribution data are as follows:

TABLE 18a

Distribution of *Microbracon pini* Mues.

Locality	Investigator	Date
Maine—		
Alfred	MacAloney	?
Burnham	Taylor	1928—June
China	Taylor	1928—June
Greene	Barnes	1926—May
Mt. Desert Id.	Johnson	1926—?July
Readfield	Taylor	1928—June
Sidney	Taylor	1928—June
New Hampshire—		
Concord	Taylor	1928—June
Durham	Taylor	1928—May, June
Oxford	Barnes	1926—May
Vermont—		
Bradford	Taylor	1928—June
Fairlee	Taylor	1928—June
Norwich	Taylor	1928—June
Massachusetts—		
Boston	Taylor	1926–28—May–August
Brookline	Taylor	1928—June
Carver	Barnes	1926—May
Dedham	Taylor	1927—May
Franklin Co.	Barnes	1926—May
Gardner	Muesebeck	?
Milton	Taylor	1926–28—May–Auust
North Beverly	Taylor	1928—June
Petersham	Taylor	1927—April, May
Saugus	Muesebeck	?
Connecticut—		
Middletown	MacAloney	?
New Haven	Barnes	1926—May
"Northwest part"	Taylor	1928—May, June
Portland	Zappe	?
Rainbow	Spring	?
Windsor	Walden	?
New York—		
Cambridge	Barnes	1926—May
Fort Ann	Barnes	1926—July
Glens Falls	Barnes	1925—July
Hudson	Barnes	1927—May
Hudson Falls	Barnes	1925—July, Aug.
Ithaca	Barnes	1925–26—May, July

TABLE 18—(*Continued*)
Distribution of *Microbracon pini* Mues.

Locality	Investigator	Date
New York—		
Johnstown	Barnes	1926—August
Lewis	Barnes	1926—May
Lowville	Barnes	1927—July
Oneonta	Taylor	1928—June
Shurtleffs	MacAloney	?
Warrensburg	Barnes	1925–26—July
Watson	Barnes	1926—July
Pennsylvania—		
Ansonia	Taylor	1928—May, June
Fayetteville	Taylor	1928—May, June
Mont Alto	Taylor	1928—May
Sizerville	Taylor	1928—June
Michigan—		
Roscommon	Taylor	1928—May, June

Description

Adult. In general coloring, the head and thorax are black, the abdomen brown, with the ventral portion more or less banded with yellowish brown at the sutures. The size range for the females is about 2.8 x .7 to 4 x .9 mm.; for the males, 2.1 x .5 to 3.4 x .8 mm. Muesebeck's description follows:

"Closely resembles *tychii*, but differs in the somewhat shorter malar space, the larger opening between clypeus and mandibles, in the presence of a distinct sharp stub of a median longitudinal ridge at the apex of the propodeum; in the first abscissa of radius being shorter than the inner side of stigma, and in the legs being usually less black.

"Female—Length, 3 mm. Head much thicker antero-posteriorly at insertion of antennae than at the lower margin of clypeus; transverse diameter of opening between clypeus and mandibles greater than the distance from the opening to the eyes, malar space much shorter than the first segment of antennae flagellum; temples not as broad as in the preceding series, postocellar line scarcely one and one-half times, ocell-ocular line less than three times, the diameter of an ocellus; antennae 31-segmented, the first flagellar segment about twice as long as broad, all the following considerably longer than broad; face and frons polished; thorax smooth and polished, parapsidal furrows sparsely hairy; propodeum polished, with a distinct stub of a median longitudinal ridge at apex; second abscissa of radius decidedly less than twice the first; the third abscissa longer than the first and second abscissae; last abscissa of cubitus much longer than the preceding abscissa; the portion of cubitus between recurrent and first intercubitus much more than half as long as the recurrent; abdomen long-oval; plate of first tergite more or less sculptured laterally and apically; second tergite reguloso-striate medially, smooth and shining laterally; third and following tergites smooth and polished; rarely the third faintly sculptured; ovipositor sheaths about as long as the abdomen beyond first tergite. Black; head and thorax wholly black; wings very slightly dusky; coxae usually mostly black or blackish, remainder of legs brownish with more or less infuscation; abdomen black; second tergite usually yellowish-brown except medially where it is black; third tergite usually somewhat yellowish along basal margin and laterally.

"Male—Agrees with the female except for the usual sexual differences. Antennae 33-segmented, the flagellar segments a little more slender than in the female."

Egg. The egg is elongate, more or less slightly curved, pearly white to pale cream-colored, smooth-looking, translucent body, which is rounded at one end and tapered at the other. This tapered end is usually hyaline. A series of eggs averaged about .81 x .18 mm.

Larva. A conspicuous general characteristic of the larva, which is yellowish to dirty-cream in color, is the numerous, more or less spherical white masses, which are readily visible through the semi-transparent body wall and are scattered throughout the posterior two-thirds of the abdomen. An early instar larva measured 1.26 x .3 mm. and had short antennae; fine hairs aided in making the lines of segmentation distinct. In the next stage larva, the antennae are smaller in proportion and the body is more plump; the fine pilosity is retained; a larva of this stage measured 1.5 x .66 mm. A larva of an intermediate stage measured about 3 x .72 mm. and showed a tendency for the first five abdominal segments to be produced ventrally so that locomotion was aided. The full grown larva is light yellow, the internal white masses are less conspicuous or absent, the antennae are still small in proportion, and the fine pilosity is still present. A full size larva taken from a cocoon measured 4.05 x 1.5 mm.

Pupa. The pupa is cream-colored and shows no unusual characters.

Life Cycle

Microbracon pini emerges the earliest of the hymenopterous parasites obtained with the exception of *Calliephialtes nubilipen-*

nis. In the spring of 1927 active adults were liberated from leaders dissected in April, at a time when *Pissodes* had not appeared on the trees to oviposit. In 1928 this species emerged from May 16 to late June but the peak of emergence which was in early June, was about three to four weeks before a majority of the weevil larvae were mature or at the optimum stage for parasitization. It would seem quite evident that *Microbracon* must wait a minimum of two weeks for the weevil grubs to be even half grown, while waits of a month or even more are probably not uncommon. It is assumed that the parasites, under natural conditions, feed on nectar during this period of waiting. The early appearance of *Microbracon* suggests the interesting possibility that this species may be in the evolutionary process of changing its host. This possibility is somewhat supported by the relative crudity of certain phases of its oviposition and by other indications, which point to a relatively unspecialized adjustment to *Pissodes strobi.*

The males precede the females by only a few days; both sexes become numerous about together, though the peak of the males is earlier. The emergence data for the species are given in Table 19.

TABLE 19
Spring Emergence of *Microbracon pini* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
May 16	2	0	May 27	7	1	June 7	100	87	June 18	2	2
17	3	0	28	11	3	8	85	152	19	0	0
18	0	0	29	20	2	9	17	38	20	0	0
19	0	0	30	10	7	10	29	101	21	0	0
20	0	0	31	25	6	11	12	43	22	0	0
21	0	1	June 1	25	10	12	8	22	23	0	0
22	1	0	2	49	18	13	6	20	24	0	0
23	0	0	3	129	62	14	3	13	25	1	0
24	0	0	4	67	64	15	2	1	26	0	1
25	3	0	5	18	13	16	0	3	27	3	1
26	0	0	6	0	0	17	4	4			
									Totals:	642	675

Copulation may take place immediately after emergence but oviposition usually does not occur for some time. In this study it was necessary to keep the parasites on ice from one to four weeks until the weevil larvae were large enough to be parasitized. Females which had been mated prior to icing oviposited at once upon introduction in the oviposition cages; others not mated until their removal from the ice-chest were not observed to oviposit before several days to a week had elapsed. Under natural conditions, with an enforced interlude of waiting, initial oviposition when the weevil larvae are but half-grown may be assured; this is, in fact, supported by several cases observed upon dissection of leaders taken from the field.

The eggs do not adhere to the host very well; they hatch in four or five days and the young *Microbracon* larvae begin to consume the nearest weevil larva encountered. The host is consumed rapidly, in less than a week, for usually there are several parasite larvae feeding upon a single host at one time. Several instances of full-sized larvae found upon half-consumed hosts indicate that a weevil grub may be too large a meal for a single parasite. After feeding is concluded, pupation immediately takes place; the parasite constructs a typical, pale yellowish-grey, paper-thin but tough cocoon. Microbracon may emerge about a week later or it may spend the winter in the cocoon to emerge the following May or June. The shortest length of time from egg to pupa that was noted was eleven days. When the adult emerges, it chews its way out of the cocoon and then through the thin bark of the leader; rarely, if ever, does the parasite bore through sound wood as *Eurytoma pissodis* does, since the cocoons are usually just under the bark or in the entrance shafts of the pupal cells. The exit holes in the bark are about 1.5 mm. in diameter.

The summer emergence is about one-third of the total emergence, or about 37 per cent; the ratio is 1 : 1.7. The females which emerge in late July or early August contain mature eggs, and since those weevil larvae which are late in their development, are still at a suitable stage for parasitization, the possibility that a partial second generation may occur exists. When placed in the oviposition cages, these summer-emergent females reacted positively to the leaders and went through the preliminary movements of oviposition. Though no eggs were obtained from the small number of females experimented with, it is suggested that, in nature, a small second generation very probably does occur.

The longevity of *Microbracon* in the adult stage is an important consideration since a certain amount of waiting before oviposition is usually necessary. The data for the longevity of some of the forced forms, kept at room temperature and fed with honey and water, are contained in Table 20. It may be noted in this table that the females in this species average a life which is only slightly longer than that of the males. The large stocks bred out in 1928 at the normal time for spring emergence were kept alive in the ice-chest for six to ten weeks, or until longer than was needed for experimentation.

TABLE 20

Longevity of *Microbracon pini*

Males

No.	Date emerged	Date died	Age in days	Total
3	3/9	3/21	12	36
1	3/9	3/23	14	14
3	3/11	3/21	10	30
1	3/12	3/21	9	9
1	3/12	3/28	14	14

Average longevity: 11.4 days.

Females

No.	Date emerged	Date died	Age in days	Total
2	3/11	3/21	10	20
1	3/11	3/23	12	12
1	3/11	3/30	19	19
2	3/12	3/21	9	18
1	3/13	3/14	1	1
5	3/13	3/28	15	75
1	3/13	3/30	17	17
1	3/13	4/4	22	22
1	3/14	3/23	9	9
1	3/14	4/4	21	21
1	3/14	4/8	25	25
1	3/16	3/28	12	12
1	3/16	4/4	19	19
1	3/18	3/28	10	10

Average longevity: 14 days.

Habits

Copulation. Microbracon employs no rudiments of courtship tactics and the male seeks to mate without any preliminary maneuvers immediately upon emergence. The female does not readily accept the male and does not remain quiescent during the act; in most cases, a tendency to elude and escape from the male was noted. Often, the abdomen was bent and the wings held tightly crossed, apparently to render copulation more difficult and, in several instances, the male was chased away. The habit practiced by the male is to pounce suddenly upon the back of the female and, by curving the abdomen under the apex of the abdomen of the female, to intrude the penis. This is accomplished with considerable effort; perhaps an average of five trials will be made before success is attained. It is of interest that the male will appear unexcited until within a centimeter or so of the female, when suddenly sex attraction apparently becomes irresistible and a quick leap is made toward the female. Males on the verge of such a pounce were often noted to be distracted by the presence of other males and to give up the attempt. The duration of copulation, as observed, ranged from one to five seconds.

Oviposition. The act of oviposition may occur from the time the weevil larvae are half-grown until they have begun their pupal cells. The weevil larvae, whether feeding or building ''chip-cocoons'' (Type Three pupal cells), when just under the paper-thin bark of the leader, give the bark a slightly irregular surface. It is evident in such cases, even to the human touch, that the location of *Pissodes* should not be difficult. The details of oviposition based upon many observations is as follows:

The female walks slowly along the shoot, with her ovipositor sheath, which completely hides the ovipositor, trailing at such an angle that its tip just clears the surface of the bark. She stops and places the entire egg-laying organ in a vertical position by bending the end of the abdomen so that it is at right angles to the surface of the leader. She remains motionless while she slowly and gently taps the bark with the ovipositor, often changing the vertical angle as she describes more or less of a circle with it. She may then move on and repeat this performance several times but, usually, she finds a satisfactory site after two or three trials. She may next apply her mouth-parts to the surface and hold the maxillary and labial palps in direct contact with the bark while her antennae alternately wave and are motionless. By this time she may appear excited and thus show that she has probably definitely located a grub. If this is the case, she quickly moves forward slightly and arranges the ovipositor and sheath vertically over the exact point which the mouthparts touched. The ovipositor moves out ventrically-anteriorly from the separating sheath members. One or two thrusts and the slender brown ovipositor, composed of two pieces, penetrates the bark.[35] When it does do, it is completely apart from the laterally-grooved surfaces of the two sheath members. These latter two pieces are used to brace the ovipositor at the point of insertion. When the ovipositor is fully inserted, the sheath members are bent double.

[35] On one occasion, one of the females observed had to make compensative efforts to regain her balance when the ovipositor suddenly overcame the resistance of the bark.

The ovipositor is then thrust back and forth in the opening in the bark, and its angle may be changed. This phase is one of exploration and of definite location of the weevil larvae. The pointed end of the ovipositor stimulates the grub to writhe vigorously; resistance, however, is futile because the space for maneuvering is limited. It would seem probable that *Microbracon* seldom, if ever, has the ovipositor bitten because the female is dextrous in changing the angle and depth of penetration of the organ.

The second phase consists of the stinging of the host larva. Apparently no particular part of the body is selected but usually the ovipositor penetrates the dorsum of the abdomen. The larval skin, though elastic and depressible, is pierced by slight alternating movements of the two parts of the ovipositor. At the time of the stinging thrust, the female apparently maneuvers carefully to thrust vertically downward, since a glancing thrust is not effective. When the weevil larva is stung, it become motionless, though the internal motion of the body fluids and the heart pulsations continue. When the ovipositor is withdrawn it leaves no visible hole and nothing exudes; the female shows no tendency to lap up juices from the stung host and it is difficult to see how she could accomplish this with bark, frass, and wood chips intervening.

When the weevil larva is definitely quieted, the eggs are laid at random on the sides and dorsum of the grub. While it is impossible to see the passage of eggs down the ovipositor, this phase can be detected by the peculiar movements of the parts of the egg-laying organ; these are similar to those which occurred in the penetration of the body wall of *Pissodes* but are more pronounced, more rapid, and longer in duration. This phase is thus marked by the rapid up and down motion of the pieces in alternation, so that when one piece moves upward the other moves downward and *vice versa*; meanwhile, the abdomen is rhythmically contracted so that finally an orgasm occurs, with the whole ovipositor moving convulsively and quivering as the eggs are forced down in an amorphous, compressed column of material. Observation of the end of the ovipositor under the bark shows that one to five eggs, but usually one or two, may issue per orgasm. When the eggs do not come separately, they resemble a string of sausage in that each egg, as it takes form, appears to be connected to the one following it. The eggs are not truly connected, however, and they soon fall apart as the slightly viscous film, which causes the temporary adhesion, dries. Each egg, as it is extruded from a point a short distance back from the apex of ovipositor, is held by one motionless member of the organ while the other member moves to place the next egg beside the first. Close observation shows that there is a definite gap between each banana-shaped egg. When the eggs are laid, either in one "string" or in several lots at short intervals, the ovipositor is slowly withdraw. Often it is twisted several times to dislodge it from the bark, and as it slips free, the pieces return to the laterally-grooved sheath members and the act is concluded.

Oviposition from start to finish has been timed at four to thirty-five minutes; the time required, of course, is dependent upon the ease of subcortical exploration, maneuvering for stinging, and upon the number of eggs laid. The act has been observed to occur three times in close succession, then to be followed by a period of rest. A characteristic of *Microbracon* is its concentration while engaged in oviposition. Other insects crawling upon the female, for example, apparently do not in the least disturb her. It was possible not only to observe oviposition on leaders removed from the cages and held horizontally under a binocular microscope but it was further possible to cut and prop up the bark adjacent to the female, and to remove frass, without interrupting her activities. With this technique, it was possible, therefore, to see the ovipositor on both sides of the bark simultaneously and under high power. Agitation of the bark with a dissecting needle apparently stimulated a female, in one instance, to emit two more eggs when on the point of withdrawing her ovipositor.

Under normal conditions, the eggs adhere to the weevil larva for several hours as a cluster. They readily become detached, however, and it becomes apparent why so few of this parasite develop in the innermost or Type One weevil pupal cells. The weevil larva when stung is only temporarily paralyzed and apparently unharmed. Apparently the paralysis wears off in about an hour for larvae have been observed to resume feeding or tunneling after such an interval. It would appear that the weevil larvae, quite commonly, may manage to scrape off the *Microbracon* eggs and to mine away from them. It would seem very probable that dislodged eggs, which are to be found in the frass, may, when they hatch, cause the destruction of *Pissodes* larvae other than those upon which they were originally laid. Usually *Microbracon* develops in the Type Two or Type Three pupal cells.

It is in the selection of prospective hosts for the deposition of the eggs, that this braconid shows an appreciable lack of efficiency. In the laboratory the females laid eggs upon weevil larvae already bearing more eggs than could be nourished when they hatched; the females did not distinguish between living hosts and dead ones, since eggs were laid upon grubs in the last stages of putrefaction; and there were cases when eggs were deposited in dry barren wood chips with no weevil larvae present. While under natural conditions it may be that the wastage of eggs is less, there is evidence here, nevertheless, of oviposition being too readily engendered and a relative lack of specialization. Several cases were noted where many *Microbracon* cocoons were in a small area, *e.g.*, 48 in 3.6 sq. cm. which would tend to indicate a concentration of oviposition activity in the vicinity of a weevil ring. The number of eggs per weevil larva which are successful, based upon 948 cocoons counted in 431 weevil pupal cells, is an average of about 2.2 parasites per host.

In an attempt to determine egg-productivity of *Microbracon*, the ovaries of 20 females were removed and dissected. Ova counts which ranged from five to twelve in nine cases gave an average of about seven for the nine considered; the number of immature eggs apparently was considerable. Five females of the summer emergence, when dissected, showed four and nine eggs in two cases (one egg came through the ovipositor under slight pressure). This last is taken as one of the bases for the assumption that this parasite may have a partial second generation. The ripe eggs in the oviducts, through they are compressed and distorted as they pass down the ovipositor, are of the same shape as they are after laying. The number of eggs laid in the laboratory was much smaller than was expected when the potentialities resident in a maximum of five eggs per act of oviposition repeated several times a day are considered. In one typical cage, 11 females in nine days produced but 17 eggs; in another, one female in two days laid six eggs; in still another, 15 females in 11 days were credited with 18 eggs.

Other habits. Both sexes eat honey and water avidly; as mentioned previously, there is no apparent tendency on the part of the female to lap up the juices of the stung host, though this is virtually prevented since the host is sheltered by the bark of the leader.

The adults are good fliers but, except when the light from one direction is considerably more intense, they did not take wing or seek to escape as vigorously as did most of the other parasites studied.

Effectiveness

Because of its abundance (though this is based principally upon the Massachusetts data) and the potentialities for a partial second generation, *Microbracon pini* is regarded as an effective parasite of the white pine weevil. In this study, on a basis of 2.2 parasites per host, it was found to account for 952, or about two to three per cent of the available mature weevil larvae in the 3009 leaders considered; the figures for the 2602 Massachusetts leaders are 879 or nearly three per cent. The effectiveness in each locality represented by material may be found in Table 12.

Although it is particularly vulnerable to birds during the winter, *Microbracon* is prolific enough to be regarded as a well established primary parasite of *Pissodes.* It is, however, much less adapted to its host than *Eurytoma pissodis,* for example. Its adjustment to the weevil may be considered relatively unspecialized on the following counts:

1. The peak of emergence occurs considerably in advance of the optimum time for parasitization; many larvae which have not attained their full size are oviposited upon.
2. The eggs are not stalked and are easily dislodged; they are laid with a certain lack of discrimination since oviposition may occur at sites where the weevil larvae are dead or even where there is nothing under the bark but frass and wood chips.
3. Usually more than one, and up to five, eggs are laid per host.
4. The cocoons of the parasite overwinter in the Type Two and Type Three pupal cells, especially the latter, where they are particularly vulnerable to bird predatism.

Eupelmus pini

Introduction

This chalcidoid, family Eupelmidae, was fourth in abundance both in 1927 and 1928, but is not sufficiently numerous to be an important factor in the natural control of *Pissodes strobi.*

History

Eupelmus pini was established as a new species in the course of this study and was described (Taylor, 1927) from types bred from leaders collected from the Stony Brook tract. A eupelmid, determined by A. B. Gahan as *E. cyaniceps* var. *amicus* Gir., was obtained by Barnes from similar material, but Gahan has since determined this species as *E. pini* Taylor; the two species are very close in appearance but there are slight differences and *E. cyaniceps amicus* was originally bred from *Bruchus amicus,* a weevil indigenous to the southwestern part of the United States.

Distribution

The distribution of this parasite is apparently limited to a small part of the range of the white pine weevil as the following records show:

TABLE 21

Distribution of *Eupelmus pini* Taylor

Locality	Investigator	Date
Massachusetts—		
Boston	Taylor	1926–28—May–July
Dedham	Taylor	1927 —May
Milton	Taylor	1926–28—May–July
Connecticut—		
New Haven	Barnes	1926 —May
New York—		
Ithaca	Barnes	1925–26—May
Oneonta	Taylor	1928 —June

Description

Adult. The greenish-purple body and purplish eyes are distinctive while the up-tilted angle at which the abdomen is usually held is a conspicuous characteristic. There is a considerable sex difference in size; the range for the females is about 2.3 x .7 to 4.4 x 1 mm., and for the males, 2 x .4 to 2.4 x .6 mm. The published description is reproduced:

Length 3.8 mm.

Head: Transverse, somewhat wider than the thorax; vertex, face, and cheeks, except front, pubescent, metallic green to purplish, purple between scapes and eyes; labrum dark, pubescent; the area of the eyes darkened more or less by irregular, dark purplish-brown patches, elsewhere light gray, not pubescent; antennal scapes not flattened but round, fitting rather snugly in scrobes, slightly curved, metallic green to blue ventrad; pedicel metallic green; no ring joints visible; funicle eight-jointed, dull black with slight iridescence, very finely pubescent, basal four joints, except first, longer and much less distinctly articulated than apical four, which are capable of greater flexibility; club composed of three segments fused, black but appears lighter than funicle because of thicker and longer light-colored down. *Thorax*: Prothorax short, much narrowed anteriorly, purple with narrow median white band present on anterior half, finely pubescent; variable in color, from brassy to bright bluish green and purple with iridescence; rugulose, pubescent at sides; pleura unicolorous with mesoscutum in general, mesoepisternum rugose medially to coarsely reticulate posteriorly and finely reticulate anteriorly, not pubescent; sternum greenish to metallic blue, rugulose, with white pubescence; axillae well separated; elongate, triangular scutellum much narowed anteriorly, rounded posteriorly, both the axillae and scutellum brassy with greenish tinge, not pubescent. Wings hyaline except for irregular light brown area near apex and below termination of veins, iridescent, punctate uniformly, except near tegulae and on a rectangular area anteriorly near the middle, with short brown hairs similar to the fine marginal fringe, except near tegulae where the hairs are larger; nervures light brown, pubescent. All coxae greenish to blue with metallic reflections, pubescence of fine, rather long white hair; hind and middle trochanters similar, sparsely pubescent, lighter than coxae to unicolorous; fore trochanters darker than coxae. Fore femora stout, curved, with center of arc anterior, flattened on inside; dark greenish-purple, almost black, with white pubescence. Front tibiae yellowish light brown with black areas anteriorly and posteriorly parallel to the long axis; tarsi with first and second joints light yellowish brown, other progressively darker, last joint and ungues black, finely pubescent. Middle femora and tibiae at base light brown, pubescent, apex of tibiae lighter and yellowish; tarsi same as fore tarsi except first joints whitish. Hind femora dark, same as fore femora, except yellowish light brown apically; tibiae same as front tibiae basally but yellowish apically; tarsi same as middle tarsi. *Abdomen*: Dorsum of anterior abdominal segment (just caudad of propodeum) bright blue-green in the anterior half, metallic reddish-purple in the posterior half; polished throughout; not pubescent; dorsum of remaining adbominal segments, except posterior one, metallic reddish-purple merging into greenish, coppery and brassy caudad; rugose, sparsely pubescent with long dark hairs; dorsum of posterior abdominal segment dark purple merging gradually into greenish coppery at apex; rugulose, sparsely pubescent with long dark hairs; all of pleura dark reddish-purple with metallic reflections merging into greenish coppery caudad. Pleura rugose in upper third; sparsely pubescent with long hairs lighter than those of dorsum; medially, rugulose to polished, not pubescent; on lower third, polished to rugulose, more strongly pubescent than the upper third; posterior quarter of the sternum greenish purple to brassy, iridescent, rugose, with many long dark hairs. Ovipositor sheaths .9 mm. long, their extreme bases black, beyond, straw yellow, merging gradually into dark brown at distal third; ovipositor yellowish brown to darker distally.

Life History

The emergence of *Eupelmus pini* occurs largely in May or June depending on the development of the season; the males, which in 1928 were about one-quarter of the total emergence, precede the females by a few days. The emergence data are given in Table 22.

TABLE 22

Emergence of *Eupelmus pini* Taylor

Date	Males	Females	Date	Males	Females
June 3	1	0	June 21	1	3
4	0	0	22	0	4
5	0	0	23	0	3
6	0	0	24	1	7
7	0	0	25	7	67
8	0	0	26	0	36
9	0	0	27	1	13
10	0	0	28	0	3
11	0	0	29	0	1
12	0	1	30	0	1
13	0	0	July 1	0	0
14	12	0	2	0	1
15	19	3	3	0	0
16	12	13	4	0	0
17	14	19	5	0	1
18	10	34	6	0	0
19	2	14	7	0	0
20	1	7	8	0	0
			9	1	0
			Totals	83	231

Eupelmus was never observed in the act of copulation. Oviposition, or more strictly, the preliminaries of oviposition, occurred frequently in the cages but no eggs could be found, either in the pupal cells or in or on the bodies of the weevil larvae; no paralyzed or dead weevil grubs were noted when the shoots were examined immediately after the females observed had apparently completed oviposition. Dissection of the ovaries of 30 females revealed no mature eggs.

In this study it was impossible to establish conclusively that *Eupelmus pini* is a primary parasite of *Pissodes*, and it belongs to a genus whose members are catholic in their tastes since they may be both primaries and secondaries of Lepidoptera, Coleoptera, and Hymenoptera; it is considered a primary of the weevil herein, however, on the following grounds:

1. The preliminaries of oviposition, as observed, occurred at the optimum time for parasitization of *Pissodes.*

2. An immature stage taken from a weevil pupal cell in the field in 1297 was reared through to an adult.

3. Barnes reports in his unpublished thesis that he has bred this species from individual weevil larvae.

Since no summer emergents have been obtained, *Eupelmus* has but one generation so far as is known. By presumption, it overwinters as a larva, prepupa, or pupa.

Habits

Oviposition. The preliminaries of oviposition were noted repeatedly throughout July, which, in 1926, was the optimum time for parasitization of the weevil. The female apparently makes a careful selection of a site for it walks slowly along the leader with the antennae, which droop so that they just touch the bark, vibrating back and forth as they also move in circles at the same time. Excitement is manifested by an increase in the tempo of this compound motion. After a site is chosen, the tip of the abdomen is depressed so that, with the aid of the ovipositor sheath, the ovipositor is placed in a vertical position. The ovipositor is then thrust through the bark and moved up and down; the whole abdomen moves more or less with the thrusts of the egg-laying organ. During oviposition one female kept one antenna motionless while the other vibrated but this is not typical, as simple vibration of both antennae during the last part of the maneuvers was characteristic of all other females observed. Several repetitions of the performance described in succession were observed in a number of instances.

Other habits. This parasite is difficult to handle because of its ability to make prodigous jumps; it also crawls very rapidly and may fly directly out of the container in the brief interval between unstopping and restopping.

Effectiveness

Because of the size of the parasite, it was assumed that *Eupelmus* probably consumes its host on a basis of one larva per weevil grub. Upon this basis, *Eupelmus* was found to account for 314 or less than one per cent of the available mature weevil larvae in the 3009 leaders considered; in Massachusetts, *Eupelmus* was credited with the consumption of 312 weevil larvae or virtually one per cent of the total number in 2602 leaders.

Rhopalicus pulchripennis

Introduction

This chalcidoid, family Pteromalidae, was fifth in abundance but its numbers are relatively so few that it is not considered an important primary parasite of *Pissodes strobi.*

Synonymy

Spintherus pulchripennis Crawford (1912).
Rhopalicus americanus Girault (1916).
Rhopalicus pulchripennis (Crawford) Gahan (1925).

History

Rhopalicus pulchripennis was first described as *Spintherus pulchripennis* by Crawford in 1912, who named and described it from specimens obtained from a *Pissodes* species at Columbia Falls, Mont. Gahan has found *Rhopalicus americanus* Gir. to be a synonym of this species, which he lists as *R. pulchripennis* because he believes it to be more properly placed in the genus *Rhopalicus* Foerster. This parasite has been obtained by several investigators, including Barnes, MacAloney, and Pillsbury.

Distribution

If it were not for the occurrence of this parasite in Michigan and the original record in Montana, it might be concluded from the data secured in this study that *Rhopalicus* is restricted to New England and New York. It is, however, apparently widely distributed over the northern range of the white pine weevil. The records are as follows:

Table 23
Distribution of *Rhopalicus pulchripennis* (Cwfd.)

Locality	Investigator	Date
New Hampshire—		
W. Swanzey	Pillsbury	1926—Sept. (larva) (pupated June, 1927)
Massachusetts—		
Boston	Taylor	1928—May, June, Aug.
Milton	Taylor	1928—May, June, Aug.
Petersham	MacAloney	?
New York—		
Canaan	Barnes	1925—August
Fort Ann	Barnes	1926—July
Ithaca	Barnes	1926—July, August

TABLE 23—(*Continued*)
Distribution of *Rhopalicus pulchripennis* (Cwfd.)

Locality	Investigator	Date
New York—		
Lowville	Barnes	1925, '27-July, August
Middletown	Barnes	1926—June
Oneonta	Taylor	1928—June
Providence	Barnes	1925—August
Ticonderoga	Barnes	1926—July
Warrensburg	Barnes	1925, '26–July
Watson	Barnes	1926—July
Michigan—		
Ann Arbor	Taylor	1928—June
Roscommon	Taylor	1928—June
Montana—		
Columbia Falls	Brunner	?

Description

Adult. The more or less vivid, iridescent bodies and bright red eyes of this parasite are striking. There is considerable disparity in size between the sexes; the males, which are rare, range about 2 x .4 mm., while the females ranged from 2.3 x .6 to 4 x .9 mm., with the mode close to the latter figures. Crawford's original description of *Spintherus pulchripennis* is as follows:

"*Female.* Length about 4 mm. Head and thorax blue with purplish tints, the abdomen brown, with the base blue; face with fine crowded punctures, appearing almost granular; mandibles 3-toothed; antennae brown, the scape testaceous, pedicel elongate, about as long as the first joint of the funicle; first ring joint almost subquadrate, the second longer than broad; thoracic notum with fine thimble-like punctures; scutellum near apex with a transverse line due to the apical portion having larger punctures; propodeum short, without a neck, with a median carina, lateral folds shallow, the area between them with very shallow indistinct punctures; prepectus and mesopleurae entirely covered with thimble-like punctures; legs rufo-testaceous, the femora more or less infuscated; front and middle coxae with a large blue spot at base; hind coxae entirely bluish; femora more or less tinged with bluish behind; wings hyaline with a large fuscous band the length of and covering the marginal vein and extending about two-thirds across wing; the anterior part much more deeply infuscated than the posterior; marginal vein slightly shorter than stigmal (about as 15:18) and slightly thickened; postmarginal much longer than marginal (about 25:15).

"*Male.* Unknown."

Egg. The egg is a creamy, torpedo-shaped body, larger at one end. Two light bands apparently are typical. A series of eggs averaged about .18 mm. at greatest width, .12 mm. at both tips, and .6 mm. long.

Larva. The first stage larva is yellowish, footless, and measures the same as the egg. No unusual characters were noted. Intermediate larval instars presented no essentially different appearance except increases in size. The mature *Rhopalicus* larva has small antennae and prominent spines below each spiracle. A characteristic of all larvae observed was the translucency of the last two or three abdominal segments posteriorly.

Pupa. The pupa is cream-colored and about the size of the adult.

Life Cycle

Rhopalicus emerges in June, or, in general, at a time when the first weevil larvae are becoming mature. The emergence data are given in Table 24.

TABLE 24

Spring Emergence of *Rhopalicus pulchripennis* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
May 27	0	1	June 4	0	1	June 12	0	3	June 20	0	0
28	0	0	5	0	0	13	2	4	21	0	0
29	0	0	6	0	0	14	2	13	22	0	0
30	0	0	7	0	0	15	2	7	23	0	0
31	0	0	8	0	4	16	1	4	24	0	0
June 1	0	1	9	0	2	17	0	0	25	0	2
2	0	1	10	0	5	18	0	3	26	0	4
3	0	3	11	0	2	19	0	0	27	0	1
									28	1	2
									Totals:	8	63

Copulation was never observed. The males, which are but about ten per cent of the total spring emergence, were introduced in the cages with the females under different conditions without their showing any expression of sex attraction. Oviposition occurred shortly after the females were placed in the oviposition cages but, in all cases, the stocks had been kept on ice for several weeks. Females segregated after collection and kept in cages without males, oviposited as readily as did the others; this does not, however, prove parthenogenesis since the females had been associated with the males for ten or twelve hours on the scrim collection screen before segregation. The small proportion of males and their apparent apathy towards the females all suggest parthonogenesis nevertheless.

The eggs hatched in three to seven days with possible modes of about four or five days. Usually, but not always, the hatched larvae required a week or ten days in which to complete their development; the host in many cases was not entirely consumed. No cases of more than one *Rhopalicus* larva per weevil grub were noted. The shortest period from egg to pupa that was observed was 16 days. The pupal development, exemplified by a typical case, progressed as follows:

July 6—newly formed pupa; no pigment;
July 11—eyes colored light brown;
July 12—all somewhat pigmented except anterior portion of abdomen and wings;
July 14—pupal stage completed though anterior venter of abdomen of newly formed adult still light.

Spheres of feces, in the form of aggregate pellets, are excreted near the beginning of the pupal stage.

Rhopalicus has a larger summer emergence than it has in the spring; according to Table 9, about three-quarters of the total emergence occurs in the summer. It is of interest that all of the individuals that were successfully reared *in vitro* became summer emergents. Since the first of these summer emergents appear in mid-July while the last weevil larvae have not yet constructed their pupal cells or are just beginning their construction, there is a possibility of a partial second generation on *Pissodes*. The relative smallness of the spring emergence shows, however, that if any reparasitization takes place, it cannot be considerable in quantity. Females, which had been reared *in vitro*, were placed in oviposition cages July 13 and 15 but they did not react positively to the weeviled leaders nor could any eggs be found within them. While it is not known definitely in what stage the spring emergents overwinter, it would seem very probable that hibernation occurs in a naked prepupal condition.

Habits

Oviposition. Oviposition in this parasite is so similar to that in *Eupelmus pini* that no formal description of the female's maneuvers will be given. It should be added, however, that the weevil larva is definitely paralyzed by *Rhopalicus* and that the egg is placed on either the dorsum or side of the abdomen of the host. A viscous liquid was observed to exude from the ovipositor when it was extracted though much of this fluid quickly flowed back into the organ when it was sheathed. In general, it was noted that *Rhopalicus* was meticulous in selecting a site for the insertion of the ovipositor. In one hour, the preliminary depression of the abdomen in order to insert the ovipositor was observed to occur 24 times, and actual insertion occurred 16 times before the female watched found a site that was entirely satisfactory. The same female then tapped around this point with her sheath and made four trials before the essential phases of oviposition, which consumed about five minutes, were accomplished. From these elaborate preparations and prolonged explorations, the inference might be drawn that the antennae in this case are not as efficient tactile organs as they might be supposed to be, or that the number and sequence of stimuli necesary to evoke a complete act of oviposition is indeed delicate and exact.

Effectiveness

The number of eggs laid per day per female was not the subject of exhaustive study (since the time available was very limited) but some data are available. A representative oviposition cage, which contained ten females, produced 80 eggs in 8 days, or an average of exactly one egg per day per female; another, which contained two females produced ten eggs in six days, or close to the above average; still another, which contained twelve females, produced only twelve eggs in six days, or but one-sixth of an egg per day per female. In the leaders in the laboratory, about 40 per cent of the eggs found were not stuck to the weevil larvae but were loose in the frass and wood chips.

A dissection of the ovaries of ten females yielded, in four cases, 6, 6, 6, and 5, mature eggs. A dissection of the ovaries of three females of the summer emergence, gave, in two cases, ova counts of 4 and 5 mature eggs. This last supports the possibility of a small second generation on *Pissodes* (or perhaps a large generation on some other host).

The effectiveness, taken on a basis of one parasite per host—though in one instance, two parasite larvae consuming the same individual weevil larva were noted—and with the heavier summer emergence calculated and added in, was about 264, or about three-quarters of one per cent, of the available mature weevil larvae in the 3009 leaders considered.

Coeloides pissodis

Introduction

This braconid, which was sixth in abundance, is so few in numbers that its importance as a factor in the natural control of *Pissodes* is negligible. It is, however, an interesting species in that it has been known for some time and may, very probably, be the first authentic species to be described as a parasite of the white pine weevil.

Synonymy

Bracon pissodis Ashmead (1888).
Habrobraconidea bicoloripes Viereck (1916).
Coeloides pissodis (Ashm.) Viereck (1916).

History

Coeloides pissodis was first obtained as an emergent from a weeviled leader of Norway spruce at Penacook, N. H., August 19, 1886. The single speciment, a female, was sent to Ashmead, who named and described it as *Bracon pissodis.* While this parasite was referred to in several lists, it apparently was not again obtained until 1911, at Rainbow, Conn. Viereck transferred it to the genus *Coeloides.* Specimens of a species admittedly close to *Coeloides* were taken at Rainbow, Conn., in 1910 and 1920, at Yalesville, Conn., in 1912, and at Portland, Conn., in 1914; this species was named, described, and figured by Viereck as *Habrobraconidea bicoloripes.* Cushman has stated[36] that there can be no doubt that *Habrobraconidea bicoloripes* should be regarded as a synonym of *Coeloides pissodis.* Recently, this parasite has been obtained by several investigators.

Distribution

Coeloides, while not abundant, appears to be well distributed over the eastern part of the range of the white pine weevil. The records are as follows:

[36] A personal communication, 1928.

TABLE 25
Distribution of *Coeloides pissodis* (Ashm.)

Locality	Investigator	Date
Maine—		
Burnham	Taylor	1928—June, July
China	Taylor	1928—June, July
Sidney	Taylor	1928—July
New Hampshire—		
Durham	Taylor	1928—June, July
Penacook	Whitaker	1886—August
Massachusetts—		
Boston	Taylor	1926–28–May–July
Dedham	Taylor	1927—June
Gardner	MacAloney	?
Milton	Taylor	1926–28–May–July
Petersham	MacAloney	?
Plymouth Co.	Barnes	1926—May
Rhode Island—		
East Greenwich	Taylor	1928—July
Connecticut—		
Portland	Zappe	1914—
Rainbow	(Spring) Britton	1910, '12–June and ?
Yalesville	(?) Britton	1912—
New York—		
Benedicts	Barnes	1925—August
Berlin	Barnes	1926—June
Cambridge	Barnes	1926—May
Ithaca	Barnes	1925—May
Oneonta	Taylor	1928—(dissected out)
Middletown	Barnes	1926—July
Stanfordville	Barnes	1926—July
Warrensburg	Barnes	1925—July
Pennsylvania—		
McConnellsburg	Taylor	1928—July
Mont Alto	Taylor	1928—June

Description

Adult. The black head and thorax, the orange abdomen, and the long antennae are conspicuous characters of Coleoides. The size range for the females is about 4.8 x 1 to 5.6 x 1.3 mm., and about 4 x .8 to 4.4 x .9 mm. for the males. Ashmead's original description of *Bracon pissodis* follows:

"*Female.* Length $3\frac{1}{5}$ mm.; ovipositor $2\frac{2}{5}$ mm. Head and thorax, smooth, polished, black; antennae about the length of the whole insect, 40-jointed, black; the first three joints of the flagellum are only a little longer than wide and shorter than the following, the others being about twice as wide; thorax smooth without parapsidal grooves and flat in front of scutellum, the latter subconvex, elevated above the dorsal line of the mesonotum, with a transverse groove at base, the groove punctate at bottom; metathorax with a red median carina, the rest of the surface smooth and polished, black, pleura pubescent. Abdomen yellowish red; plate of 1st. segment narrowed at base, the lateral keels distinct; 2nd. segment has a long, narrow, triangular shield medially, extending from base to apex of segment, with lateral foveae or grooves; the whole surface of these two segments is wrinkled, the following segments smooth, polished; ovipositor yellowish, its sheaths black. Wings black, stigma and veins brown; the recurrent nervure joins the 1st. submarginal cell between the middle and the apex, the first transverse cubital oblique, the 2nd. submarginal cell small, subtrapezoidal."

Viereck's description of *Coeloides pissodis* is as follows:

"First dorsal abdominal segment yellowish red, as is the remainder of the abdomen; length 3.2 mm.; ovipositor with its exserted portion 2.6 mm. long."

The description of *Habrobraconidea bicoloripes* is omitted but is readily available in the Hymenoptera of Connecticut, pp. 764–765.

Egg. The egg is pearly white, much elongated and tapers at one end, which is translucent at the tip. The egg measures about 1.56 mm. long and .18 and .08 mm. in width at the wide and narrow ends respectively.

Larva. The larva closely resembles that of *Microbracon pini* in color and in the presence of globular white bodies in the posterior two-thirds of the abdomen but is larger in each stage. A mature larva measured about 5.4 x 1.5 mm.

Pupa. The pupa is cream in color and the eyes, when the color appears, are a light brownish red. The large ovipositor of the female pupa is prominent. One pupa measured 5.4 x 1.5 mm.

Life History

Coeloides emerges between the peaks of the spring emergence of *Microbracon pini* and *Eurytoma pissodis*; in 1928, the spring emergence ranged from mid-June to mid-July. The data are given in Table 26.

Copulation occurs immediately upon emergence and oviposition shortly afterward. The eggs were difficult to obtain. One egg was noted on the surface of the bark of a weeviled leader, apparently dropped there by a female when the ovipositor was extracted;

TABLE 26
Spring Emergence of *Coeloides pissodis* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
June 13	3	0	June 22	0	0	July 1	0	0	July 10	0	1
14	3	1	23	0	0	2	2	2	11	0	0
15	4	0	24	0	1	3	0	0	12	0	0
16	0	0	25	0	10	4	0	1	13	0	0
17	0	0	26	1	10	5	0	1	14	0	0
18	1	2	27	0	2	6	0	0	15	0	0
19	0	0	28	0	3	7	0	0	16	0	1
20	0	0	29	0	0	8	0	0	17	0	1
21	0	1	30	0	0	9	0	0	Totals:	14	37

another was found near a weevil larva just under the bark. Because of the relatively large size of this parasite, it is assumed that not more than one *Coeloides* larva could successfully develop on an individual weevil larva; never more than one larva or one cocoon per pupal cell was observed. The leaders from one oviposition cage which contained three females, when dissected, yielded nine larvae (six mature) and two cocoons at the end of *seven* days; this indicates that the development of the immature stages of Coeloides is very rapid. The three young larvae in this case, became pupae nine days later.

Almost half of the total emergence, or about 44 per cent, occurs in the summer if the data obtained in 1928–29 are typical. Since the summer emergents do not appear until *Pissodes* itself is on the verge of emergence it would seem improbable that there is any partial second generation parasitic on the weevil; whether another host is parasitized by this braconid is unknown.

Three adults of this species, kept at room temperature and fed with honey and water, lived an average of 24 to 25 days; this is a greater longevity, under the same conditions, than obtained with any other parasite, except *Lonchaea corticis.*

Habits

Copulation. The act of mating is rapid. The male shows a preliminary excitement by alternate periods of rapid vibration of the wings and pauses before it leaps upon the female. The male, with most of its body beneath the abdomen of the female, is frequently carried along by the latter. Actual mating requires but a few seconds.

Oviposition. In its essentials, oviposition in *Coeloides* is so similar to that in *Microbracon pini* that no complete description will be given. The flexible ovipositor is so long that bending during insertion is common. The duration of the act as observed was about 25 minutes. In several instances, a drop of liquid at the end of the ovipositor upon withdrawal was noted; when this organ is drawn out of the bark, the whole abdomen is elevated in a characteristic manner to accomplish this. The ovipositor and sheath are cleaned with the hind legs before the female walks slowly away to a new site.

The weevil larva is severely stung and paralyzed beyond the point of reaction to stimulus, though the heart pulsations were observed to continue after stinging. In several cases, however, stung larvae were found that had apparently been killed since no heart movement could be discerned. It was so difficult to find eggs either in, on, or near the bodies of the stung weevil larvae that it would seem a reasonable inference, if the observation made in the oviposition cages are typical of what occurs under natural conditions, that more weevil larvae are stung (with some dying as a direct result) than eggs are laid. If this inference is correct, then *Coeloides pissodis* may be a more valuable parasite than its few members would otherwise indicate.

Effectiveness

The data on the productivity of the females of *Coeloides* are as follows: Three females in seven days produced nine larvae and two pupae, as determined by a dissection of the leaders in the cage; in another cage, eight females in three days produced two eggs and two larvae. Five females, when their ovaries were dissected, were found, in two cases, to contain fifteen and two mature eggs.

The effectiveness, based on the assumption of one parasite per host and with the summer emergence calculated and added in, was found to be 97, or about one-quarter of one per cent of the mature weevil larvae in the 3009 leaders considered.

Calliephialtes nubilipennis

Introduction

This ichneumonid, which was seventh in abundance, is a negligible factor in the natural control of *Pissodes strobi.*

Synonymy

Exeristes nubilipennis Viereck (1912).
Calliephialtes nubilipennis (Viereck) Cushman.

History

Calliephialtes nubilipennis was first obtained from a species of *Pissodes* at Columbia Falls, Mont., May 10 to 15, 1911. The specimens were turned over to Viereck, who described and named the parasite *Exeristes nubilipennis.* When the specimens obtained in the course of this study were determined by Cushman, they were labeled "*Calliephialtes.*" No references in the literature in regard to this species except the original description were found.

Distribution

Calliephialtes, while obtained in very small quantity, is evidently widely distributed over the northern part of the United States east of the Rockies. The records are as follows:

TABLE 27
Distribution of *Calliephialtes nubilipennis* (Vier.)

Locality	Investigator	Date
Maine—		
Sidney	Taylor	1928—May
Massachusetts—		
Boston	Taylor	1928—May, June
Milton	Taylor	1928—May, June
Petersham	MacAloney	?
Pennsylvania—		
Fayetteville	Taylor	1928—May
Michigan—		
Roscommon	Taylor	1928—May
Montana—		
Columbia Falls	Brunner	1911—May

Description

Adult. This large, slender ichneumonid is black with whitish bands at the sutures of the first three or four abdominal segments in ventral aspect. The length of the males obtained was about 8 mm., the width at the widest part of the thorax, about 1 mm.; the females were a millimeter or so longer. The original description of *Exeristes nubilipennis* follows:

"*Female.* Length 9.5 mm., agrees with *Exeristes hyalinipennis* Viereck, from which it may be separated by the darker wings, the nervellus which is broken above the middle, and the smooth, highly polished lateral aspects of the pronotum."

For the sake of completeness and convenience, the following description of *Exeristes hyalinipennis* is added:

"*Female.* Length, 9 mm.; of the European species of *Exeristes* and allied genera and subgenera this apparently agrees best with *Exeristes roborator* Fabricius, from the typical form of which it may be distinguished by the smooth, poorly punctured head, thorax and propodeum; by the nervellus being broken below the middle; by the reddish and blackish hind femora; by the blackish hind tibae with stramineous base; by the blackish hind tarsi with the base of the first segment of the metatarsus stramineous; by the black vaguely punctured abdomen and by the first, dorsal segment being apparently longer down the middle than wide at apex. This species may prove to be only a mutant of *Exeristes nubilipennis* Viereck."

The type locality and other data of this latter species were given as similar to those of *E. nubilipennis.*

Life History

Of the 18 specimens bred out, but three females were included. This parasite was the first to emerge and all of the emergence took place in May or early June, both in the cages and in the breeding room. Copulation occurred immediately upon emergence; the preliminaries of oviposition were noted a month later. (In view of the early stage of development of *Pissodes* at this time, immediate oviposition was out of the question.) No eggs were obtained.

From the size of the parasite, which in the opinion of Cushman is probably a primary of the white pine weevil, it would seem certain that not more than one parasite larva could possibly develop successfully from a weevil grub, and also, that a full-sized grub would be required. If this supposition is correct, then a waiting period of at least a month is necessary before the optimum time for parasitization arrives.

No data on longevity were secured since all individuals obtained were placed on ice and kept there from three to six weeks. It is presumed that this parasite hibernates in the pupal stage.

No summer emergence was obtained. The data for the spring emergence are as follows (Table 28).

Habits

Copulation. Mating occurred very readily and was rapid. In general, the male leaped upon the back of the female, quickly curved the tip of his long abdomen underneath that of the female so that the genitalia came together, and then jumped off. The duration of the act in most cases was not over three of four seconds,

TABLE 28

Spring Emergence of *Calliephialtes nubilipennis* in 1928

Date	m.	f.	Date	m.	f.	Date	m.	f.	Date	m.	f.
May 8	3	0	May 15	1	0	May 22	0	0	May 29	0	0
9	0	0	16	0	0	23	0	0	30	0	0
10	0	0	17	1	1	24	0	0	31	2	0
11	0	0	18	0	0	25	1	1	June 1	3	0
12	0	0	19	1	0	26	0	0	2	1	0
13	0	0	20	0	0	27	1	1			
14	1	0	21	0	0	28	0	0	Totals:	15	3

though upon one occasion the attitude of copulation lasted a full minute. One female was mated with by several different males six times in one hour. Upon one occasion, a male attempted copulation with another male.

Oviposition. The maneuvers and postures of oviposition were observed shortly after the introduction of the parasites in the oviposition cages. When the ovipositor is first inserted, the body of the female droops so that the long organ is bent at a sharp angle and extends along the ventral surface of the abdomen and thorax, at which latter region it is braced before it is thrust into the weeviled leader. After insertion, the tip of the abdomen is held at an acute angle so that the ovipositor moves back and forth on a plane perpendicular to the bark.

Selection of a site is aided, apparently, by the application of the mandibles and other mouthparts to the surface of the bark. A number of trials are usually made before a site is selected.

Though all three females worked diligently on the leaders in the cages for a period of ten days apiece, no eggs were found either in, on, or near, the weevil larvae, and no paralyzed grubs were noted.

Other habits. *Calliephialtes* immediately sought out and located its fresh food without difficulty, which is in contrast with most of the other hymenopterous parasites which are less quick to respond to the introduction of fresh food. In general, this parasite was restless and active during the entire time it was exposed to the light; both males and females were continually dropping from the top of the cage and crawling back.

Effectiveness

If it be assumed that *Calliephialtes* consumes a single weevil larva each, then the parasite was responsible for 18, or about one twentieth of one per cent of the available mature weevil larvae in the 3009 leaders considered.

Spathius sp.

This braconid is included here for the sake of completeness. Twelve individuals (four males and eight females) were taken in the summer emergence from material collected near Milton, Mass., in mid-July, 1928. It may be noted that these specimens all emerged on August 30, 1928, and also that the species did not appear in the forced spring emergence from the identical material.

This parasite was determined by Gahan and Cushman as a *Spathius* species very close to *S. brachyurus* Ashm., but not quite the same. Records show that the genus is apparently restricted to Coleoptera; in view of this, the presumption is that this parasite is probably a primary of *Pissodes*. Because of its rarity, *Spathius* cannot be considered at all important from an economic viewpoint. The adult measures about 3.2 x .6 mm. and is a light brown in general coloration. The antennae are much shorter than is usual in the genus.

Pleurotropis n. sp.

Introduction

This small black chalcidoid, family Eulophidae, which measures about 1.3 x .4 mm., is by far the most abundant secondary parasite of the white pine weevil; indeed, it was the fourth most common parasite obtained. The host is *Lonchaea corticis* Taylor.

History

Pleurotropis n. sp. has been obtained by several recent investigators but as yet it is undescribed. There was not time in the course of this study to describe this species since a revision of the genus at the same time would have been advisable.

Distribution

As the following records indicate, this small parasite is widely distributed over the entire range of *Pissodes*.

Table 29
Distribution of *Pleurotropis* n. sp.

Locality	Investigator	Date
Maine—		
Burnham	Taylor	1928—June, July
China	Taylor	1928—June, July

TABLE 29—(*Continued*)
Distribution of *Pleurotropis* n. sp.

Locality	Investigator	Date
Maine—		
Greene	Barnes	1926—May
Readfield	Taylor	1928—June, July
Sidney	Taylor	1928—June, July
New Hampshire—		
Concord	Taylor	1928—June, July
Durham	Taylor	1928—June, July
Lebanon	Barnes	1926—May
Oxford	Barnes	1926—May
Vermont—		
Bradford	Taylor	1928—June, July
Fairlee	Taylor	1928—June, July
Norwich	Taylor	1928—June, July
Massachusetts—		
Boston	Taylor	1928—May–July
Bridgewater	Barnes	1926—April
Carver	Barnes	1926—May
Franklin Co.	Barnes	1926—April, May
Middleboro	Barnes	1926—April
Milton	Taylor	1928—May–July
Petersham	MacAloney	?
Plymouth Co.	Barnes	1926—May
Rhode Island—		
East Greenwich	Taylor	1928—July
Connecticut—		
New Haven	Barnes	1926—May
"Northwest part"	Taylor	1928—June, July
New York—		
Berlin	Barnes	1926—June
Cambridge	Barnes	1926—May
Hudson	Barnes	1927—May
Ithaca	Barnes	1925, '26–May
Lewis	Barnes	1926—May
Oneonta	Taylor	1928—June, July
Warrensburg	Barnes	1927—May
Pennsylvania—		
Ansonia	Taylor	1928—June, July
Blain	Taylor	1928—June, July
Fayetteville	Taylor	1928—June, July
McConnellsburg	Taylor	1928—June, July
Mifflinburg	Taylor	1928—June, July
Milroy	Taylor	1928—June, July
Mont Alto	Taylor	1928—May–July
Renovo	Taylor	1928—June, July
Sizerville	Taylor	1928—June, July
Ohio—		
Mentor	Taylor	1928—June, July
Michigan—		
Ann Arbor	Taylor	1928—July
Roscommon	Taylor	1928—June

Life History

The emergence of *Pleurotropis* extends over several months and begins in April or May depending upon the development of the season. The data are given in Table 30. There is no summer emergence so far as is known. In general, the emergence in the spring roughly coincides with that of the host, *Lonchaea corticis.*

TABLE 30
Emergence of *Pleurotropis* n. sp.

Date	No.	Date	No.	Date	No.	Date	No.	Date	No.
May 28	1	June 10	53	June 23	0	July 6	8	July 19	6
29	0	11	2	24	0	7	30	20	0
30	0	12	15	25	93	8	19	21	2
31	0	13	18	26	62	9	32	22	0
June 1	3	14	11	27	42	10	28	23	1
2	3	15	21	28	29	11	43	24	1
3	13	16	4	29	0	12	48	25	4
4	4	17	6	30	0	13	21	26	5
5	0	18	8	July 1	36	14	7	27	0
6	0	19	0	2	72	15	23	28	0
7	37	20	0	3	35	16	11	29	1
8	16	21	4	4	57	17	1		
9	0	22	0	5	37	18	11	Total:	984

While no experiments were carried on with this parasite, there seems no doubt that it often parasitizes the fly heavily. Barnes, who reports rearing *Pleurotropis* from puparia of *Lonchaea,* has also noted the marked positive correlation between the relative abundance of the eulophid and of its host; *i.e.,* when the former is obtained abundantly, the fly is less so and *vice versa.*

It is probable that *Pleurotropis* oviposits on, or in, nearly mature *Lonchaea* larvae which are just under the bark. The fly larvae or pupae are apparently consumed while within the puparium; it thus seems very probable that the parasite spends the winter in the puparium of its host. Since no summer emergents were obtained in a sample of over three hundred weeviled leaders, it is assumed that *Pleurotropis* has but one generation a year.

Effectiveness

From a count of the small exit holes in the bark, about .5 m. in diameter, over the puparia, it was estimated that an average of about three *Pleurotropis* parasites are derived from each parasitized *Lonchaea* puparium. The counts on which this estimate is based are 82 exit holes over 27 parasitized puparia; the range was apparently one to four.

No definite statement concerning the effectiveness of this parasite can be given from the insufficient data on hand. It is evident, however, that the potentialities of this secondary are considerable. A judgment based upon the *Pleurotropis*-riddled appearance of some of the leaders dissected would be that the percentage of parasitism of *Lonchaea* may rise as high as 50 per cent and possibly higher.

If it be assumed that each *Pleurotropis* represents one third of a *Lonchaea* puparium, then (referring back to Table 10) each individual parasite may be said to represent the indirect consumption of about one sixth of a weevil larva. On such a basis, *Pleurotropis* was listed in Table 12 as accounting for about 172, or about one-half of one per cent. of the mature weevil larvae in the 3009 leaders considered.

Eucoila sp.

Introduction

This medium-sized cynipid, about 2.5 x .6 mm., is not uncommon emergent from material weeviled by *Pissodes strobi*. It is classed as parasitic upon Diptera by Gahan, which thus makes it a very probable secondary of the weevil with *Lonchaea corticis* Taylor for its host.

History

Since this species of *Eucoila* has not yet been definitely determined, no history can be given. This same species, however, has been obtained by several investigators recently.

Distribution

This parasite appears to be well distributed over the northern part of the white pine belt. The records are as follows:

Table 31
Distribution of *Eucoila* sp.

Locality	Investigator	Date
Maine—		
China	Taylor	1928—July
Sidney	Taylor	1928—July
New Hampshire—		
Concord	Taylor	1928—July
Durham	Taylor	1928—July

TABLE 31—(*Continued*)
Distribution of *Eucoila* sp.

Locality	Investigator	Date
Vermont—		
Bradford	Taylor	1928—July
Massachusetts—		
Boston	Taylor	1928—June, July
Milton	Taylor	1928—June, July
Petersham	MacAloney	?
Rhode Island—		
East Greenwich	Taylor	1928—July
New York—		
Ithaca	Barnes	1926—May
Oneonta	Taylor	1928—July
Pennsylvania—		
Ansonia	Taylor	1928—July
Blain	Taylor	1928—July
Fayetteville	Taylor	1928—July
Milroy	Taylor	1928—July
Michigan		
Ann Arbor	Taylor	1928—July
Roscommon	Taylor	1928—July

TABLE 32
Spring Emergence of *Eucoila* sp. in 1928

Date	No.	Date	No.	Date	No.	Date	No.	Date	No.
June 29	1	July 3	5	July 7	4	July 11	3	July 15	1
30	3	4	17	8	5	12	3	16	2
July 1	1	5	9	9	1	13	5	17	4
2	14	6	2	10	3	14	2		
								Total:	85

Effectiveness

The effectiveness of *Eucoila* is purely problematical. Based upon the size of the parasite, it would seem probable that only one parasite could successfully develop from a single *Lonchaea* puparium. Even though the summer emergence appears to be about equal to the spring emergence and a second generation on the fly would be quite possible, *Eucoila* is not sufficiently numerous to be an important factor in the bionomics of *Lonchaea*. This parasite was omitted from consideration in Table 12 because the data were insufficient.

Hemiteles humeralis

This ichneumonid, represented by two females which emerged June 17, 1928, from material collected on the Stony Brook tract, is, in the opinion of Cushman, "A secondary of *Pissodes strobi.*" It belongs to a genus which is known to be more or less parasitic upon other hymenopterous parasites. It is listed here for the sake of completeness but its rarity precludes its being of economic importance. Provancher's original description based upon three females follows:

> "Female. Long. .15 pouce. Noir; les antennes, la partie antérieuer du prothorax, les épaules se joignant à une tache sur les flancs du mesothorax, les pattes y compris les hanches et les trochantins, roux. Les cuisses postérieures au milieu et les jambes à l'extrémité sont lavées de brun. Ailes hyalines, nervures brunes, blanches dans le bas; écailles blanches, stigma brun, sans tache blanche à la base; une large bande brune partant de la base du stigma traverse l'aile; aréole à nervures presque toutes entourées de blanc, la nervure extérieure manquant. Abdomen en ovale à partir du 2ᵉ segment, noir, poli, brilliant les segments 1 et 2 roussâtres à la base et à l'extrémité, les autres marginés de même postérieurement, les derniers tachés confusément de blanc. Tarière un peu plus longue que la moitié de l'abdomen, celuici y compris le segment 2, quelquefois presque entièrement roussâtre."
>
> The females obtained in this study measured about 3.9 x .7 mm.

2.—PARASITES OBTAINED FROM WEEVILED LEADERS BY OTHER WORKERS

In the literature and in the unpublished lists of Barnes, MacAloney, and Plummer, there are a large number of parasites obtained from weeviled material. An attempt has been made to make the list given in Table 33 complete. In all cases, these species are rare for the source mentioned and, in many cases, they have never since been obtained. Some references are given in the bibliography at the end of this paper.

It is cautioned that this list is *not* to be taken as a supplementary list of the parasites of the white-pine weevil, since all parasites that emerge from weeviled leaders are by no means necessarily connected with *Pissodes strobi.*

In regard to parasitic Diptera, there is one record in the literaure of the well known tachinid, *Compsilura concinnata* Meigen, as

Table 33

A List of Hymenopterous Parasites Reported from *Pissodes strobi* or from Weeviled Material by Other Investigators

Note: The records of Barnes, MacAloney, and Plummer (includes Pillsbury) have never been published and were kindly offered for incorporation in this paper.

Name	Family	Investigator	Remarks
Spathius brachyurus Ashmead	Braconidae	Hopkins	Recorded as a parasite of *Pissodes strobi*. Bred from cocoons; Kanawha Stn. and Morgantown, W. Va., 1890–1898.
Spathius canadensis Ashmead	Braconidae	MacAloney Barnes	Obtained at Petersham, Mass., and Ithaca, N. Y., respectively. Host records in the literature are all scolytids.
Microbracon nanus Prov.	Braconidae	Zappe	Portland, Conn., 1914.
Heydenia unica C. & D.	Braconidae	Hopkins	Bred from larvae and cocoons found in mines of *Pissodes strobi*. Berkeley Spngs., and Charleston, W. Va., 1897, 1893 respectively.
Doryctes n. sp.	Braconidae	MacAloney	Petersham, Mass., ? 1927. Specimen so labeled was *Coeloides pissodis*.
Aleiodes (*Rogas*) *aciculatus* (Cresson)	Braconidae	MacAloney	Petersham, Mass., ? 1927.
Meteorus vulgaris (Cresson)	Braconidae	Barnes	Considered by Muesebeck as "An abundant parasite of Noctuidae of the cut-worm type."
Cyanopterus sp.	Braconidae	Britton	Stafford, Conn., 1911. Thought by Rohwer that it may not be a parasite of the white pine weevil.
Microtypus ? ("*Microtyphus*") sp.	Braconidae	Barnes	New York state, about 1926.
Phygadeuon nitudulus Provancher	Ichneumonidae	MacAloney	Petersham, Mass., about 1927.
Labena apicalis Cresson	Ichneumonidae	Barnes	Obtained abundantly at Mont Alto, Pa., May, 1926. References give a curculionid and cerambycids as hosts.
Calliephialtes comstockii (Cresson)	Ichneumonidae	Houser Barnes Pillsbury	Bred in Ohio; in Mass., Conn., and N. Y. in 1925, 1926; W. Swanzey, N. H., Sept., 1926, respectively. Bred from weevil larvae and moth, *Dioryctria* n. sp. by Barnes. Cushman states that "This species is normally a parasite on lepidopterous larvae on conifers."

TABLE 33.—(*Continued*)

Name	Family	Investigator	Remarks
Epiurus sp.	Ichneumonidae	Peirson	Petersham, Mass., about 1921.
Schenckia ? ("*Schenkia*") sp.	Ichneumonidae	MacAloney	Petersham, Mass., about 1927.
Megaspilus sp.	Ceraphronidae	MacAloney	Bred at Rainbow, Conn.
Prosynacra sp.	Diapriidae	MacAloney	Petersham, Mass., about 1927.
Brachymeria tarsata (D. T.)	Chalcididae	Barnes	New York state, about 1926.
Eurytoma tomici Ashm.	Eurytomidae	Barnes	New York state, about 1926. Recorded from *Tomicus*, a scolytid.
Eurytoma tylodermatitis Ashm.	Eurytomidae	Barnes	Warrensburg and Middletown, N. Y.; about 1926. Recorded from curculionids and *Araeocerus*.
Eurytoma cleri Ashm.	Eurytomidae	Hopkins	Found in mines of *Pissodes strobi* at Charleston, W. Va., 1893. Hopkins, at time, believed an error in determination had been made. This species is close to *E. pissodis*.
Berecyntus bakeri How.	Encyrtidae	MacAloney	Petersham, Mass., about 1927.
Rhopalicus suspensus Ratz.	Pteromalidae	Britton Plummer	Bred at New Haven, Conn., 1914; Durham, N. H., mid-June, 1927, respectively.
Homoporus sp.	Pteromalidae	MacAloney	Rainbow, Conn. Host: Diptera?
Coelopisthia suborbicularis Provancher	Pteromalidae	Pillsbury	Durham, N. H., late May, 1927.
Arthrolytus ? ("*Arthrostylus*") sp.	Pteromalidae	Barnes	New York state, about 1926.
Paracrias sp.	Eulophidae	Peirson	Petersham, Mass., about 1921.

parasitic upon the white pine weevil. This record is a peculiar one in several respects and it is felt that a brief discussion of the case is merited. Webber and Schaffner make the following statement:[37]

> "So accustomed have we grown to the ever-increasing host list of Compsilura that a new record obtained from some lepidopteron causes but little comment. There have been but few collections of coleopterous larvae, however, and none has ever given the parasite. A rearing attended by peculiar cir-

[37] Webber, R. T. and Schaffner, J. V., Jr. 1926. Host relations of *Compsilura concinnata* Meigen, an important tachinid parasite of the gipsy month and the brown-tail moth. U. S. D. A. Dept. Bul. 1363: p. 27.

cumstances was reported to the writers by C. W. Johnson, of the Boston Society of Natural History, who in 1914, recovered the parasite from the white pine weevil (*Pissodes strobi* Peck). In September of that year he was looking over some of the mounted specimens of various insects in the Libby Museum at Wolfboro, N. H. One mount containing a terminal shoot of white pine, illustrating the work of the weevil, contained a fly which seemed out of place. Upon inquiry it was found that the mount had been made up as usual and that the fly must obviously have issued after the mount was completed. At Johnson's request the fly was given him, and he identified it as *Compsilura concinnata.* Since there was no puparium in sight, the maggot evidently pupated with the burrow of the host.''

It would seem that the evidence given above is too inconclusive to warrant any assumption that *Compsilura* parasitized *Pissodes* in this case. The fly, which is reasonably common, has never since been obtained from a weeviled white pine leader by any investigator (and it is stated above that no other coleopterous larvae have ever yielded *Compsilura*). It is suggested that the host in this isolated case was some lepidopteron, of which there are a number in such a situation, *e.g., Dioryctria* n. sp.

In covering all cases where *Pissodes* may be parasitized, parasitization artificially encouraged may, perhaps, be included. It is of interest that the Texan parasite, *Scleroderma macrogaster,* and the Phillippine species, *S. immigrans,* have been successfully reared upon the larvae and pupae of *Pissodes strobi.*[38] It is here suggested that workers with hymenopterous parasites of the type that oviposit upon an uncovered larva or pupa may find the immature stages of the weevil, which is so abundant during June and July, a worth while source of food for such cultures.

3.—OTHER PARASITES OBTAINED INCIDENTALLY IN THIS STUDY

It was deemed advisable to reserve for this paper a cursory discussion of a number of parasites, each species of which was represented by only one or several individuals, which are *not* connected with *Pissodes strobi* so far as is known. The following list includes those parasites which emerged from the breeding room or from the breeding cages along with the parasites of the weevil. All determinations of these were also made by Gahan and Cushman and

[38] Wheeler, W. M. 1926. Les Sociétés d'Insectes: p. 67.
Keeler, C. E. 1929. Pysche: 36: 42.

their records, in many cases, have given clues to the probable hosts. It might, perhaps, be useful to key all the parasites that may emerge from coniferous leaders weeviled by *Pissodes,* but for the present, the annoted list below must suffice for these incidental parasitic forms.

TABLE 34

A List of Parasites Obtained Incidentally and *not* Believed to be Parasitic upon *Pissodes strobi*

Name	Family	Emergence data	Remarks
Bassus annulipes (Cresson)	Braconidae	1 female—Sizerville, Pa., July 9, 1928.	Host: Lepidoptera?
Aphaereta sp.	Braconidae	1 male—Oneonta, N. Y., June 3, 1928. 1 female — Fayetteville, Pa., June 7, 1928.	Host: Diptera?
Hemiteles hydrophilus Ashmead	Ichneumonidae	1 f. Boston: 5/7/28 1 m. Boston: 5/27/28 1 m. Boston: 5/29/28 1 m. Boston: 6/4/28 1 m. Boston: 6/9/28 1 f. Concord, N. H., May 29, 1928.	In Cushman's opinion, this parasite is very possibly a secondary of *Pissodes.*
Chaeretymma velox (Cress.)	Ichneumonidae	1 female—Boston, Mass., June 8, 1928.	Host: A sawfly?
Poemenia americana (Cresson)	Ichneumonidae	1 male—Boston, Mass., June 15, 1928.	Host: Probably a cerambycid.
Delomerista n. sp.	Ichneumonidae	7 females—Boston, Mass., June 5 to 10, 1928.	Hosts: Probably sawflies. This species has also been obtained by Cushman and a description by him is in process of preparation.
Mesoleius sp.	Ichneumonidae	1 male—Boston, Mass., June, 1928.	Host: A sawfly.
Monoblastus varifrons (Cresson)	Ichneumonidae	1 male—Readfield, Maine, June 10, 1928. 1 female—Boston, Mass., June 14, 1928.	Host: A sawfly.
Dicaelotus sp.	Ichneumonidae	1 female—Boston, Mass., June 24, 1928.	Hosts: Lepidopterous pupae.
——————— Orthocentrini	Ichneumonidae	4 males—Boston, Mass., June, 1928.	In poor condition: indeterminable to genus.

TABLE 34
A List of Parasites Obtained Incidentally and *not* Believed to be Parasitic upon *Pissodes strobi*

Name	Family	Emergence data	Remarks
Limnerium solenobiae Ashmead	Ichneumonidae	1 male—Boston, Mass., June, 1928.	Host: *Solenobia.*
———————	Diapriidae	1 male—Roscommon, Mich., July 9, 1928.	
Eurytoma sp.	Eurytomidae	1 male—Boston, Mass., Sept., 1928.	
Eupelmus n. sp.	Eupelmidae	2 females—Boston, Mass., July 4, 7, 1928.	
Ptinobius sp.	Eupelmidae	2 females—Boston, Mass., June 28, 1928.	Host records of genus are all coleopterons.
Cecidostiba sp.	Pteromalidae	1 female—Boston, Mass., July 9, 1928.	*C. thomsoni* Cwfd. was obtained from a *Pissodes* sp. in Montana.
———————	Pteromalidae	1 male—Boston, Mass., July 7, 1928.	Indeterminable.
Habrocytus sp.	Pteromalidae	5 females—Boston, Mass., May, June, 1928. 1 female—Bradford, Vt., June 1, 1928. 1 female—Sidney, Maine, June 3, 1928.	
Elachertus pini Gahan	Eulophidae	1 — Roscommon, Mich., May 15, 1928. 16—Bradford, Vt., May 27–30, 1928. 6—Boston, Mass., June 1, 2, 1928. 2—Readfield, Me., June 10, 1928.	According to Cushman, this species is a gregarious parasite of *Rhyacionia frustrana* Comstock. Obtained from *Dioryctria* n. sp. by Barnes.

A.—THE INSECT PREDATORS OF PISSODES STROBI

Among those forms which are arbitrarily classified as predators because they do not show the refinements and specializations of of the so-called parasites, are several clerid larvae and one caterpillar. These will be treated briefly.

Hydnocera verticalis Say

This common clerid was the most abundant of all the predators obtained. The emergence extended over June and early July, or at a time when many parasites were emerging. The total obtained from the Massachusetts material in 1928 was 524 while one individual of this species was obtained in each case from the "Northwest part" of Connecticut (June 26, 1928), Mont Alto, Pa. (June 28, 1928), and Fayetteville, Pa. (July 2, 1928). This species was also bred from weevil larvae in 1927 and experiments were undertaken at that time to measure its effectiveness. One test with six *Hydnocera* larvae and twelve mature weevil larvae confined together in a watch glass, resulted in the consumption of seven of the latter; the average consumption in this case was about one weevil grub per clerid larva. This average is not regarded as more than a rough approximation and it seems quite probable, when the relative emergence periods of the predator and the prey are compared, that a single *Hydnocera* larva may consume more than one of the immature weevil larvae. In estimating the possible effectiveness of this species, however, the "one-per-one" basis was taken and, on this basis, *Hydnocera verticalis* was held to account for the destruction of 527, or about one and one-half per cent, of the total available mature weevil larvae in the 3009 leaders considered.

For a description of the larva, the paper by Böving and Champlain[39] will be found adequate.

The adult has powerful mandibles and, when confined with adult hymenopterous parasites in a shell vial, destroyed several of them. The investigator who handles these relatively small (about 3.5 mm.) beetles without care may receive palpable bites.

The data on the larvae of *Hydnocera verticalis* in the paper mentioned, are as follows:

> "Harrisburg, Pensylvania. Larvae reared from *Celastrus* infested with Cerambycidae. F. C. Craighead. Lynn, Connecticut, *Hydnocera* larvae apparently predaceous on *Phymatodes amoenus* in wild grape. Champlain."

Placopterus thoracicus Oliv.

Placopterus thoracicus, another common clerid, was second in abundance among the predators. The emergence peak is perhaps one or two weeks before that of *Hydnocera verticalis*; emergence ranges from May to mid-June, or probably earlier, depending upon the development of the season. No individuals were obtained later than June 20 in 1928. The adults mate immediately upon emer-

[39] Böving, A. G. and Champlain, A. B. 1920. Larvae of North America beetles of the family Cleridae. Proc. U. S. N. M. 2323, 57: 623.

gence and many of them were taken from the scrim collection screen of the breeding room while *in copula.* The number obtained from the Massachusetts material in 1928 was 332; a single additional individual was taken from the Fayetteville, Pa., cage on June 14, 1928.

Several *Placopterus* adults were bred from weevil larvae in 1927 but no tests were made to determine the maximum number of mature weevil larva which might be eaten by one clerid larva. If the "one-per-one" basis be arbitrarily assumed, then *Placopterus thoracicus* may be held accountable for 333, or about one per cent of the available mature weevil larvae in the 3009 leaders considered.

The data on the larvae of this species in Böving and Champlain's paper are as follows:

> "Is a predator on the smaller barkbeetles and borers in twigs and limbs of deciduous trees. W. F. Fiske states in his notes: 'This species was very common in the jarring for *Curculio* in Georgia in 1901. And without question is an enemy of *Scolytus rugulosus.*'
>
> "The adults may be taken during the summer months upon the foliage of trees and sometimes on flowers.
>
> "Early larval stage not noted. At Lyme, Connecticut, it overwinters in the abandoned pupal cells of *Magdalis olyra* in hickory and probably preys upon the *Magdalis* broods. Also found overwintering in the galleries of *Oncideres* in hickory twigs, infested with *Chramesus icoriae* (*hicoriae*), and in butternut twigs infested with small Cerambycid larvae.
>
> "The larvae were all prepupal in their cocoon-like cells, lined with the frothy exudation and attached to the wood.
>
> "Observations by Hopkins, Fiske, Champlain. Pennsylvania, Kirk, Knull."

Other clerids

Several other clerids were obtained from the breeding room as follows:

Phyllobaenus dislocatus (Say)

June, July, 1928. 18 specimens.

According to Böving and Champlain:

> "Is a predator on small Scolytoids and other small borers. Adults observed feeding on *Pityophthorus* attacking red oak. Are active during daytime, April to August. They may be found on and flying about infested trees where they feed, mate, and oviposit.

"The larvae are to be found in the larval mines of small wood and bark borers, where they prey upon the borer broods. They are predaceous on *Elaphidion villosum* in oak twigs; *Chramesus icoriae* (*hicoriae*) in hickory twigs; *Micracis* in redbud; *Scolytus mutica* and *Agrilus lecontei* in hackberry; and will probably attack almost any small borers in deciduous trees.

"Probably occurs in most of the eastern half of the United States, southwest to Texas.

"Observations by Hopkins, Fiske, Craighead, Kirk, Champlain."

Hydnocera unifasciata Say

June, July, 1928. 12 specimens.

According to Böving and Champlain:

"Tryon, North Carolina. Larvae from galleries of *Hyperplatys* in sumac. W. F. Fiske."

Thanasimus dubius (Fab.)

September 10, 1928. 1 specimen.

According to Böving and Champlain:

"Is a predator on barkbeetles, *Ips, Dendroctonus, Polygraphus*, etc., *Pissodes* and other borers in coniferous trees, mostly pine and spruce."

An account by Hopkins[40] too long to be given here is quoted.

From the above notes, though none of these last clerids are definitely known to prey on *Pissodes strobi,* it would seem a fair assumption that they are all incidental or occasional predators of the weevil.

Graham[41] reared an individual of *Monophylla* (*Elasmocerus*) *terminata* (Say) from a clerid larva " . . . found in the weeviled shoots, evidently feeding on the larvae of Pissodes. . . . " This species has not been obtained more recently by other investigators.

Several earlier writers[42] state that "the young" of the family Tenebrionidae are predacious upon the larvae of *Pissodes strobi* but no one who has since worked on the white-pine weevil has corroborated this.

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[40] Hopkins, A. D. 1899. W. Va. A. E. S. Bul. 56.

[41] Graham, S. A. 1926. The biology and control of the white pine weevil, *Pissodes strobi* Peck. Cornell U. Agr. Ex. Sta. Bul. 449, p. 27.

[42] Riley, C. V. 1885. U. S. D. A. Rept. for 1885; pp. 322–325.
Packard, A. S. 1890. Fifth Rept. U. S. Ent. Com.

Dioryctria n. sp.

This lepidopteron, family Pyralididae, is not uncommon in white pine leaders weeviled by *Pissodes*. Barnes was the first to note that these caterpillars, which feed on the frass left by the weevil, are not only predacious upon the weevil larvae but apparently actually manifest a disposition to seek this prey in preference to the frass diet. A characteristic habit of this species, which was determined by Forbes as new, is that of boring tunnels in the pith from one weevil pupal cell to another. It is evident that the weevil larvae or pupae in the cells entered by the caterpillar are consumed.

It was noted in this study that only the caterpillars of the summer generation of this moth can be predacious on *Pissodes*. The first adults appear early in the spring, prior to, or at, the initial oviposition of the weevil. The second emergence of the moth occurs in late July or early August, based upon the 14 specimens obtained from the Massachusetts material and the three from the Durham, N. H., material. The progeny of this summer generation, which is, perhaps, but a partial one, cannot prey upon *Pissodes* as the weevil is no longer in the larval stage in August.

Four *Dioryctria* caterpillars, which are a light pinkish-brown in color, were dissected out of the Massachusetts material in late July; these were full-grown and did not molest the weevil pupae with which they were confined. A count of eleven tunnels showed that 53 weevil pupil cells were passed through. Since the larvae and pupae in these cells were apparently consumed (there was no evidence of exit), an average of about five mature weevil larvae or pupae per one *Dioryctria* larva was obtained. On this basis, the caterpillars were found to have consumed approximately 105, or about one-quarter of one per cent of the mature weevil larvae in the 3009 leaders considered.

5.—NEMATODES

In the frass, behind the weevil ring, especially when water is not entirely absent, nematodes may be found in large numbers. Barnes noted this first and he also noted, in the course of the dissection of adult weevils, the presence of hundreds of nemas under the elytra of the curculio, on the dorsum of the abdomen, at the bases of the wings, and in the metacoxal cavities. This was corroborated in this study and it may be said that almost any adult weevil will show, upon examination, a tangled mass of young-stage nemas at the sites mentioned. The presence of nematodes on the adults as well as in the frass of the leaders suggests the possibility that one period of the nema's life is spent in the shoot and another on the weevil.

One species obtained by Barnes was determined for him by N. A. Cobb as a *Diplogaster* species. Nemas obtained from the moist frass of the shoots in this study were determined by G. Steiner as a new species of *Rhabditolaimus* Fuchs. Dr. Steiner states in correspondence, "Hitherto only two species of this genus have been known and both are described in a paper by Dr. Gilbert Fuchs, entitled 'Die Naturgeschichte der Nematoden und einiger anderer Parasiten. 1. des *Ips typographus* L.; 2. des *Hylobius abietis* L.' in Zoologische Jahrbucher Vol. 38. I suppose that the life history of this new form may be somewhat similar to one of the forms of Fuchs, which live in the mines produced by *Ips typographus* L. and *Hylobius abietis* L.

"It is very probable, as you suggest, that the weevil, *Pissodes strobi*, carries the larval stages around under the wings, and it is also very probable that they stay there over winter."

It was impossible in this study to spare the time for an attempt to work out the life history of the nema determined as *Rhabditolaimus* n. sp., but such a study would be extremely interesting because the exact role of nematodes in the bionomics of the white-pine weevil is not known. In the paper cited above, where Fuchs discusses the presence of *Diplogaster butschlii* under the wing covers of *Ips typographus,* the relationship that exists between the nemas, *Rhabditolaimus leukarti, Diplogaster hylobii, D. lineatus,* and the weevil, *Hylobius abietis,* is described as a form of symbiosis.

Barnes found undetermined nematodes in the adipose tissue of weevil larvae and pupae and in the bursa copulatrix of an adult female. In this study, though no definite evidence can be given, the impression was gained that the hundreds of nemas which line the anterior portions of the elytra do not affect the vigor of the adult weevils, at least not during the mating and oviposition periods, though, presumably, the nematodes have been there over winter. No cases of external parasitism of *Pissodes* larvae or pupae were noted, and it would seem that, if internal parasitism is practiced by the nematodes, at least the insect is not rendered unable to complete its life cycle. There is no evidence that the large number of young weevil larvae which die before maturity, or any fraction thereof, owe their death to nematodes. Whether they are symbiotic, mildly parasitic, or otherwise, nematodes are not considered an important factor in the natural control of *Pissodes strobi.*

III. A DISCUSSION OF THE FEASIBILITY OF APPLIED PARASITE CONTROL OF *PISSODES STROBI*

Native Parasites

The two sections immediately preceding this one have been concerned with the identity of the insect parasites of the white-pine weevil, an attempt to learn something about them, and an attempt to measure their effectiveness. In review, of the eight primary parasites observed in the course of this study, but three are sufficiently effective to be discussed in connection with the possibilities of applied parasitism. These include:

Eurytoma pissodis Gir.—about six per cent in effectiveness;
Lonchaea corticis Taylor—about five and one-half per cent;
Microbracon pini Mues.—about two and one-half per cent.
Total of these three—about fourteen per cent.

It may be noted that these three parasites are about three times as effective as all the other parasites and predators taken together, for when this latter group is added in, the total ascribed to parasitism and predatism, based upon emergence, is but 19 per cent of the mature weevil larvae. Based upon dissection of the leaders, the maximum total that can be ascribed to parasitism and predatism in the 3009 leaders considered is only between 26 and 27 per cent.[43] These figures are not to be considered as *exact,* of course, but they should be reliable approximations and the sample worked with, about three thousand leaders, would seem large enough to be indicative of the degree of parasitism in 1927.

It is thus indicated that the presumably native parasites of this native weevil do not have a very high degree of effectiveness, certainly not as high as would be desired and sought for in the selection of parasites for applied natural control. It should not be concluded *a priori,* however, that the parasites named above have no possibilities for applied parasitism until the data obtained are analyzed and the potentialities of these species duly measured. ''Measurement'' implies a ''scale'' and it is believed that the outline developed by Smith,[44] which apparently is a condensed version

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[43] In several of the small lots of material, the figures for the maximum percentage rose as high as nearly 59, nearly 54, and nearly 53 per cent; it should be recalled, however, that these leaders were more or less selected for a high parasite content.

[44] Smith, Harry S. 1919. On some phases of insect control by the biological method. Jour. Ec. Ent. 12: 288–292.

of Pierce's[45] outline, provides such a basis for the preliminary measurement of parasites in regard to their possibilities for use.

The practicability of artificial propagation of parasites and their use as agents of control, according to Smith, depends on:

1. The comparative reproductive capacity of the host and of the available parasites: The host must not outbreed the parasites.

2. The powers of locomotion of the insect pest and those of its natural enemies: In general, if the host is a good flier a tract may be reinfested after control measures, other than parasites, have been applied; additionally, if the parasites are good fliers they may disperse and considerably lower their concentration in an area in which liberations have been made.

3. A sequence[46] of available parasites: It is desirable to employ a set of parasites that will, without competition, progressively parasitize all the stages of the host insect.

4. The possibility of rearing or obtaining the proposed parasites in sufficient quantities: This is one of the most important factors and unless the parasitic forms are rearable in great numbers success is very improbable.

5. The cost of producing natural enemies in comparison with the value of the crop and with the effectiveness of the existing methods of artificial control: Applied parasitism is justified, not when it may barely equal the effectiveness of artificial control, but only when it exceeds the latter.

6. The presence of secondary parasites in the local fauna.

7. The undesirability of applied parasitism under certain agricultural conditions: *e.g.*, where several pests infect the same host plant and only one is controllable by the parasites employed, biological methods are not the best mode of attack.

These points will be discussed with reference to the three parasites of *Pissodes strobi* named above.

1. *Comparative reproductive capacity.* It is quite evident that *Eurytoma, Lonchaea,* and *Microbracon* do not lose nearly as large a proportion of their eggs and early stage larvae as does the host,

[45] Pierce, W. D. 1908. Factors controlling parasitism with special reference to the cotton boll weevil. Jour. Ec. Ent. 1: 315–323.

[46] Thompson does not agree that a series of parasites from egg to adult is necessary to check a species, and holds that this applies only to a limited group of special cases. Reference: Thompson, W. R. 1923. A criticism of the "sequence" theory of parasitic control. Ann. Ent Soc. of Amer. 16: 115–128.

Pissodes, in whose case probably only from 2.5 to 5 per cent of the eggs laid in one season are represented by adults the following spring. While these parasites have a much higher percentage come to maturity, from the data obtained, it seems very doubtful whether *Eurytoma* or *Microbracon* lay as many eggs per female as does the weevil; *Lonchaea,* possibly, may lay as many or even more than *Pissodes.* In general, it would seem that the parasites have a considerably greater *net* reproductive capacity *per individual* than the host.

2. *Comparative powers of locomotion.* The white pine weevil should be regarded as a good flier potentially, and it is quite apparent that pruned areas, for example, are usually well reinfested before the season is over, or at least not permanently cleared of the insect. The flying abilities of the parasites, while not known specifically, are probably sufficiently great to allow for dispersion in all cases. No positive conclusions can safely be drawn here.

3. *Sequence of parasites.* No single egg parasite of *Pissodes* was obtained and it would seem that egg parasites of the types known would be ineffective in parasitizing the weevil eggs *in situ* because of the pitch which regularly surrounds them. *Lonchaea* maggots consume *Pissodes* larvae from an early instar through to the close of the pupal stage; *Microbracon* often parasitizes half-grown weevil larvae; *Eurytoma* parasitizes mature weevil larvae and pupae only. These three parasites furnish something of a sequence among themselves, though there is some competition for the mature weevil larvae in the weevil ring and *Lonchaea* is suspected of consuming the hymenopterous forms as well.

Parasites for the eggs and early instar larvae of *Pissodes,* from the standpoint of eventual or future control, are quite unnecessary, since about 80 to 90 per cent of the young weevil larvae may be expected to die from starvation.[47] It would seem that in this case, the subject of sequence may be disregarded.

4. *The possibility of rearing Pissodes parasites in the laboratory.* The experience gained in this study has shown that there are no particular difficulties attached to the breeding out of the parasites from weeviled material. It is obvious, however, that the parasites thus obtained have literally been taken from an area infested by *Pissodes.* To liberate these bred out forms in another area, even

[47] From a standpoint of the salvage of the current crop, parasites of the early stages of the weevil are theoretically valuable in checking injury before it extends too far down the leader, *i.e.,* below a whorl.

if, theoretically, not a single individual is lost, is merely to apply a credit to this tract and a debit to the tract from which the material was taken. Except in an infrequent case, where an infested area is to be abandoned, and where the transfer of parasites to a plantation recently infested by the weevil may be justified,[48] this juggling of parasites would not be sound practice.

The possibility of *increasing* the numbers of the parasites in the laboratory depends on the elaboration of a technique that (1) will result in adults developing from all eggs obtained, and (2) will result, finally, in *more* parasites than would have occurred under natural conditions. It is difficult to see how this could be accomplished without the successful development of other abundant hosts, or even of artificial nutritive media; some progeny could, perhaps, be obtained from the summer emergents, which in most cases cannot reparasitize *Pissodes*. All this may be possible, but when the great care needed to keep the cultures free from mites and molds is added to the labor necessary to collect a large quantity of weeviled leaders, it would seem that the cost would be prohibitive for an economic measure. It should be borne in mind that the parasites obtained in this study are not as easy to manipulate or to culture for egg production as those species which oviposit freely upon naked larvae or pupae. It must be further emphasized that two of the three parasites under discussion are not productive of eggs in captivity. No eggs at all were obtained from *Lonchaea* in the oviposition cages, and very few, indeed, from *Eurytoma*. This specific disinclination to oviposit productively in the cages might be overcome by a greater simulation of the natural environment but the comparative reluctance of these two species would probably remain a factor with which to reckon. In view of the above, it is thus suggested that the possibility of rearing any of the three parasites in question in large quantities and economically is not encouraging.

5. *Comparative cost of producing parasites and of other methods of control.* It is difficult to estimate the cost of producing parasites of the weevil even approximately, but it is apparent that the cost would be much greater than that of any of the various artificial measures discussed in section AI, *i.e.*, collection of adults by jarring, pruning the weeviled leaders, pruning plus the con-

[48] In these exceptional cases, the desired transfer could be accomplished by the simple removal of leaders pruned in March or early April to the new tract where the parasites could emerge under natural conditions.

servation of the parasites in screened containers, banding, spraying, *et al.* Since it is more or less generally conceded that these artificial measures are too expensive for the control of *Pissodes* on large tracts, it would seem that applied parasitism in this case is thoroughly impracticable on this ground alone.

It is true, of course, that the value of a crop of undeformed white pine is such, that if any of the artificial methods mentioned, or if the use of *Eurytoma, Lonchaea* or *Microbracon,* promised a high rate of effectiveness, the use of one or more of these measures or parasites might be justified. Such, however, is not the case with any artificial method now known, and with a host of the type of *Pissodes strobi,* it is believed that such would not be the case with the parasites named either.

6. *Presence of secondary parasites. Eurytoma* and *Microbracon,* apparently are relatively free from secondaries; *Lonchaea* is more or less heavily parasitized by *Pleurotropis* n. sp. and very probably also by *Eucoila* sp. to some extent. These secondaries mitigate the potentialities of *Lonchaea,* the most prolific form.

7. *Unfavorable agricultural practices.* Most of the other insect enemies of white pine are conspicuously rare or absent on weeviled leaders, so that there should be no question here of other insects benefitting by the use of parasites for the control of *Pissodes* and the discontinuation of other (artificial) methods.

From the foregoing it is concluded, under present conditions and with our present knowledge of the host and of its native parasites, that the control of *Pissodes strobi* by the applied parasitism of these native parasites is not feasible.

Exotic Parasites

The feasibility of applied parasitic control of this highly destructive pest of *Pinus strobus* is not, however, a closed question for there is the possibility of a high degree of effectiveness on the part of some prolific parasite, or series of parasites, introduced from another country or from an area far removed from the white pine region. Two such regions which should be explored are the western United States and northern Europe.

In the western part of the United States, it may be recalled that there are several species of *Pissodes* that mine coniferous leaders, *viz., P. terminalis* Hopping on *Pinus contorta, P. sitchensis* Hopk. on *Picea sitchensis,* and *P. engelmanni* Hopk. on *Picea engelmanni.* Undoubtedly these weevils have their parasites, one or more of which might prove adaptable to *P. strobi* and which might, by a high degree of parasitization, justify their colonization on a large scale. The parasites of the weevils just named should be studied.

Europe presents a broader field and offers more promise, probably, for the possible discovery of a highly effective parasite for the white pine weevil. Of the several European species of *Pissodes*, *P. piniphilus* is reported as mining the leaders of *Pinus*, while *P. notatus*, the most abundant, which usually mines the bark of young trees of *Pinus* and *Picea*, is reported to often mine in the leaders of the same. Other species include:

P. pini ....the thick bark of *Pinus*, *Picea*, and *Larix*
P. validirostris ....cones of *Pinus*
P. scabricollis ....tops of *Picea*
P. hercyniae ....twigs of *Picea*
P. piceae ....twigs and bark of *Abies*

A large number of parasites have been bred out of such material but their habits and life histories are still a virgin field. Dr. K. Escherich,[49] in regard to the parasites of the European species of *Pissodes* says, in effect:

"Considering the many parasites, other than the species named . . . that must exist, we biologists still know comparatively few; it is here that a great field lies before the practical entomologist. . . . "

A list of parasites from several sources follows:

TABLE 35

The European Parasites of the Genus *Pissodes* as Reported

Host	Parasite	Reference
Pissodes notatus	*Brachistes atricornis*	
	Brachistes firmus	
	Brachistes robustus	
	Bracon disparator	
	Bracon incompletus	
	Bracon initiator	
	Bracon labrator	
	Bracon palpebrator	
	Bracon sordidator	
	Ephialtes carbonarius	
	Eupelmus azureus	

[49] Escherich, K. 1923. Die Forstinsekten Mitteleuropas. Vol. 2, p. 387. Writer's translation.

TABLE 35—(*Continued*)
The European Parasites of the Genus *Pissodes* as Reported

Host	Parasite	Reference
Pissodes notatus		
	Eurytoma ischioxanthus *Eurytoma* sp. *Hadrocerus unispinosa* *Hemiteles melanarius* *Hemiteles modestus* *Microdus abcissus* *Neurateles papyraceus* *Pimpla brevicornis* *Pimpla laticeps* *Pimpla linearis* *Pteromalus ?aemulus* *Pteromalus clavatus* *Pteromalus dahlboni* *Pteromalus guttatus* *Pteromalus lunula* *Pteromalus pellucens* *Pteromalus suspensus* *Pteromalus virescens* *Spathius brevicaudis*	Elliot, E. A., and Moreley, Claude. Hymenopterous parasites of Coleoptera. Trans. London Ent. Soc., 1906; pp. 46–47. 1907.
	Metacolus unifasciatus	Mercet, R. G. Calcidoidecos parásitos de Curculiónidos y Escolítidos. Rev. Fitopatologia. ii–iii; pp. 40–47. 1926.
Pissodes pini	*Bracon hylobii*	Lyle G. T. Some Braconidae new to Britain. Ent. Mo. Mag. 61: 118–123. 1924.
	Pteromalus pini	Elliot and Moreley.
Pissodes hercyniae	*Brachistes atricornis* *Pimpla terebrans* *Sigalphus curculionum* *Xorides crassipes* *Xorides hercynianus*	Elliot and Moreley.
Pissodes piniphilus	*Bracon palpebrator*	Elliot and Moreley.
Pissodes in general (additionally)	*Sigalphus striatulus*	Escherich, K. Die Forstinsekten Mitteleuropas. Vol. 2, pp. 386. 1923.

While this list is impressive, there would seem little doubt that it includes many parasites of Lepidoptera and sawflies which are more or less common in weeviled material.[50] There is the possibility

[50] If all the parasites now reported from leaders weeviled by *Pissodes strobi* were gathered indiscriminately in one list, the total, 57, would surpass the list given for *P. notatus* by 26; yet, but eight primaries of the white-pine weevil were obtained in this study and, of these, but three are important.

that several of the species listed above, or others yet to be discovered, might prove desirable immigrants to the white pine and Norway spruce forests of the United States and welcome auxiliary agents in the control of the destructive *Pissodes strobi*. It is a possibility that should not be neglected.

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SUMMARY

The same headings and subheadings which were used in the body of this paper will be used to divide up the summary. In the first section, which is largely a historical review of the work done on the host, original findings are underlined.

A. The Host

I. The Biology of the White Pine Weevil

The native weevil, *Pissodes strobi* (Peck), whose distribution approximately coincides with the range of its chief food plant, is the most serious enemy of the white pine, *Pinus strobus,* injures Norway spruce, *Picea abies* (*excelsa*), and Scotch pine, *Pinus sylvestris,* frequently, and attacks a number of other pines and spruces occasionally. This coleopteron has long been an economic pest and its numbers are apparently increasing because of the practice of pure plantations and the consequent upset of the natural balance fostered by the virgin mixed hardwood and coniferous forests.

Pissodes does not kill the trees *in toto* but destroys the terminal shoots of saplings, and often several whorls of laterals as well, by its larval consumption of cortex, phloem and cambium, and its pupation burrows in the xylem. This destruction of the leader invariably causes loss of height growth and usually the resultant tree furnishes a knotty or a bayonet-shaped log; thus in terms of the whole stand, this loss in prime timber is so considerable that it tends to discourage the future planting of white pine.

The life cycle, briefly, is as follows: The weevil has but one generation a year; possibly some individuals may live several seasons. The adults appear on the leaders in the spring when the mean temperature reaches about 60° F.; they at once feed on the bud cluster or tender bark, copulate, and, in a day or so, oviposit. The oviposition period is at least six weeks in duration, with the peak in the first few weeks; each female lays 100 to 125 eggs (*100 eggs when* *measured averaged .788 × .488 mm., which is about half the size given in the literature*) at, or near, the tip at first, later, in advance of the mined zone, and, commonly, on several shoots. *The newly-hatched larvae mine downward, apparently because of the position of their food supply and not because of positive geotropism; larvae which do not mine downward starve and this number has been estimated to be fully 80 to 90 per cent of the number of eggs laid. Larvae timed in 20 leaders, under natural conditions, mined downward at the average rate of 1.64 cm. per 24 hours* (*though their progress in passing a whorl was much slower*). After the larvae, most of the time in a compact "ring," mine from one to three feet, they cease feeding and excavate pupal cells. The approximate length of the stages of the life cycle are: The eggs hatch in 6 to 19 days; the larvae feed 4 to 6 weeks; they remain in their pupal cells 10 to 14 days; the pupation period itself requires about 12 days more; finally, the adults do not emerge for at least a week, the emergence occurring very largely in August. The emerged adults feed for a few days and then lapse into a torpid state during the heat of late summer; this period merges into the true hibernation period, which is passed in the forest litter just above the soil, but the latter may be preceded by an interval of fall flight and an occasional semblance of mating. Probably no true mating occurs in the fall, however, and, in any event, the undeveloped condition of the ovaries of the new females renders oviposition impossible. *The critical stage in the life cycle for parasitism, in most cases, is when the weevil larvae are mature and about to construct the pupal cells. The host and the parasites may not be simultaneously at optimum stages for parasitism because of a differential rapidity of response to temperature.*

The adults reach the leaders (a) by crawling up all the way, (b) by flight to part way up the tree and crawling the remainder, and (c) by flight directly to the leader. Positive phototropism and negative geotropism are the chief factors responsible for this conduct. *There is evidence, which, though not entirely conclusive, strongly indicates that the weevil may fly or be wind-blown long distances and thus infest new areas.* It appears that the taller and more thrifty trees are selected. While it is true that when the weevil is abundant the majority of the trees may belong to the common height class (and thus tree selection may seem a matter of chance), *it would seem that this is very probably due rather to the abundance of the insect with a necessary attack* en masse. In slight infestations, the dominant trees are the targets of weevil oviposition.

Many methods of artificial control have been suggested but few effective measures without mitigating factors have been developed. Summarized, these include:

Collection by jarring: Expensive, not entirely reliable, and not feasible for large tracts.

Banding: Often highly effective for ornamentals but much too costly for plantations.

Pruning of weeviled leaders: Recommended by all investigators, of some effectiveness if done thoroughly (the shoots may be burned but, preferably, the parasites should be preserved by caging the leaders over winter with a mesh of 12 or 14 strands per inch across one or both ends of the container), *but fresh infestations are not precluded because of weevil flight;* this method is not expedient under forest conditions.

Sprays: Occasionally effective for ornamentals but too expensive and impractical under forest conditions.

Of the silvicultural methods, based upon the phototropic weevil's avoidance of shade and more applicable under forest conditions, the following have been recommended:

Mixed planting of Pinus strobus and P. sylvestris: Probably not desirable usually; the data are conflicting.

Pure dense stands of white pine: The value of this recommendation is open to question since the critical factor is often the *abundance* of the insect; *the injurious effect of dense coniferous plantings upon the forest soil does not appear to have been adequately considered.*

Mixed plantings of hardwoods (*or Tsuga*) *and white pine:* Apparently the best method for large tracts; *even here, in abnormal springs, the weevil may infest the stand before the hardwood foliage appears, since the insect responds more quickly to temperature than do the deciduous trees.*

Any possibility of applying biological methods of control to the weevil must depend upon a preliminary survey which will include (*a*) *a determination of the native parasites and predators,* (*b*) *a study of their habits, and* (*c*) *a measurement of their effectiveness and an analysis of the situation based upon the data obtained. These points are developed in the remainder of the paper.*

The following preliminary statistics on natural control are given:

Average number of middle-sized larvae in 116 shoots: About 26.
Average number of mature larvae in 3009 shoots: About 12 (yet as few as four or five mature weevil larvae can kill a leader).

The fate of the mature weevil larvae in 3009 leaders was as follows:

Successfully emerged	*About*	*49–50%*
Eaten by birds (about 29% effective in attacked shoots)	"	*17–18%*
Stuck in the attempt to emerge	"	*3– 4%*
Drowned in pitch	"	*2– 3%*
Remainder, to be accounted for by parasites, et al.	"	*26–27%*

If the number of hibernating adults lost over winter ranges from one half the total to zero, then the number of eggs represented by mating forms the following spring is but 2.5 to 5 per cent. This degree of success nevertheless provides, theoretically, for a small but definite increase of the insect every year.

B. The Parasites

I. Breeding Methods, Apparatus, and General Data Secured

The parasites of *Pissodes strobi* were found to hibernate in the weeviled leaders, which thus comprised the material to be collected. The best time to collect the shoots proved to be early in the spring before the hardwood foliage and ground cover appeared to obstruct the vision and to hinder movement; the parasites are thus left longer under natural conditions. It was found that material subjected to several weeks of freezing weather, followed by confinement in an ordinary greenhouse, would yield parasites several months in advance of the normal time of emergence and that these forced parasites came out in the same order as those in the field later.

The apparatus used was as follows:

Forcing: Six inch test tubes, sealed at the large end with $\frac{1}{4}''$ of plaster of Paris and plugged at the other, burned-out end with cotton, proved serviceable. Great care must be used to keep the cultures of naked parasites free of the voracious mite, *Pediculoides ventricosus.*

Normal emergence: (A) A cage, which consisted of a flowerpot glued to a grass plate (opaqued) and with the small aperture leading into a test tube plugged with cotton at the burned-out end, proved effective but was not efficient because of the excessive labor attendant to its construction in quantity. (B) An entire room, made tight with gummed paper strips, with a scrim collecting screen over the window opening, proved highly satisfactory and allowed a large number of parasites and predators to be bred out with a minimum of labor. (C) Cages, which consisted of 26 gauge galvanized sheet iron cylinders, one yard by six inches, with one end covered with black sateen and the other fitting into a sleeve of the same cloth and a pint glass jar, were found to be highly satisfactory for small lots of leaders confined separately for parasite distribution data.

Storing: 21 x 66 mm. shell vials proved satisfactory. It was found advisable to keep the stocks in an ice-chest to prevent loss of vigor or death before the optimum time for parasitization was reached. (Molds of the genera *Aspergillus* and *Penicillium* proved difficult to eliminate in the ice-chest and invaded many life-history cultures.)

Mating: Copulation was readily observed in the shell vials.

Oviposition: Cages were constructed of lamp chimneys stuck in sand, which either contained a small bottle of water or was moist, fitted over sections of weeviled leaders, and topped with scrim; other cages consisted of lamp chimneys scrim-screened at both ends and containing several leaders placed horizontally. Both of these cages proved satisfactory with most of the species under observation.

Life-history observation: Glass cell-slides especially constructed for the purpose were employed; the host larva and parasite (egg or early instar larva) were placed in a glass cell roofed with a glass cover slip held in place by honey. It was difficult to obtain optimum humidity and thus to avoid desiccation on the one hand and mold on the other, but placing bits of the cell-slides in petri dishes aided in this.

The parasites of *Pissodes* emerge as follows:

1. *Calliephialtes nubilipennis* (Vier.), 2. *Lonchaea corticis* Taylor, 3. *Microbracon pini* Mues., 4. *Rhopalicus pulchripennis* (Cwfd.), 5. *Pleurotropis* n. sp., 6. *Eupelmus pini* Taylor, 7. *Coeloides pissodes* (Ashm.), 8. *Eurytoma pissodes* Gir., and 9. *Eucoila* sp. *Hemiteles humeralis* Prov. and *Spathius* sp. (obtained only in the summer) uncertain. The curves of emergence of most of these parasites are bimodal because the males precede the females. A fair

amount of positive correlation between the weather, particularly temperature, and emergence was found to exist. Parasites of the same species from widely separated localities mated as readily as those from the same region. Of the first nine listed above all but *Calliephialtes* and *Pleurotropis* were found to emerge in the summer as well as in the spring; the proportion of summer emergence to spring emergence from a sample of 335 leaders was determined for each parasite in order to compute the total effectiveness of each species in the 1927 material. In but two instances, *Microbracon* and *Rhopalicus,* does any possibility of a small partial second generation on *Pissodes* exist.

Statistics derived from the dissection of leaders collected in 1928 and applicable to conditions in 1927 are as follows:

Fate of the Mature Weevil Larvae in 1927

Items in the natural control of mature larvae	Nine states other than Massachusetts	Massachusetts	Grand total
Number of shoots	407	2602	3009
Number of pupal cells	4585	31351	35936
Number of exit holes	1564	16149	17713
Per cent of weevil emergence	34.11	51.82	49.29
Number consumed by birds	801	5534	6335
Per cent of bird consumption	17.47	17.65	17.62
Number stuck in emergence as adults	254	1148	1402
Per cent stuck	5.55	3.66	3.90
Number of pitch-drowned larvae	119	763	882
Per cent pitch-drowned	2.59	2.12	2.45
Number to be accounted for	1847	7757	9604
Per cent of "remainder"	40.29	24.74	26.72

Based upon these counts, the average number of pupal cells per leader is about 12; the average of weevils which emerge, about 6; average consumed by birds, about 2; average stuck, and average pitch-drowned, about one-half and one-quarter of an individual, respectively; and the average number of mature weevil larvae to be accounted for, principally by parasites and predators, about 3 per leader. This last figure, 9604 for all the leaders, represents the *maximum* amount that can be ascribed to parasitism; the minimum is based upon the number of emerged parasites times the number of hosts, or fractions thereof, which an individual of a given species is found to consume on an average, *e.g.*, 2.2 *Microbracons* per host, 1.9 *Lonchaea*, 5.7 *Pleurotropis* (a secondary, hence indirectly), *Dioryctria*, a predator, 1 per 5 hosts, all others, by assumption or by proof, 1 per host.

The effectiveness of the parasites by species, listed in the order of their importance (based on the sum of the counted spring emergence and the calculated summer emergence) is as follows:

Total per cent of mature weevil larvae to be accounted for			26.72%
Eurytoma pissodis	5.93%		
Lonchaea corticis	5.36%		
Microbracon pini	2.65%		
Eupelmus pini	.87%		
Rhopalicus pulchripennis	.73%		
Coeloides pissodis	.27%		
Calliephialtes nubilipennis	.05%		
Secondaries	.48%		
Total parasitism		16.35%	
Hydnocera verticalis	1.46%		
Placopterus thoracicus	.92%		
Dioryctria n. sp.	.29%		
Total predatism		2.68%	
Total of parasitism and predatism combined			19.03%
Discrepancy			7.69%

This "discrepancy" is ascribed largely to parasites and predators which consumed the host and then failed to emerge for several reasons, principally because of their consumption by birds which work the leaders all through the winter.

The conclusions drawn from these data are:

1. The native parasites of *Pissodes strobi* are a factor of limited value in the control of the mature weevil larvae.

2. Collectively, the parasites rank very close to birds in percentages of effectiveness in weevil control.

3. The "balance of nature" appears to be weighted in favor of the curculio in that about 50 per cent of the mature weevil larvae successfully emerge.

II. *The Several Parasites*

Eurytoma pissodis Gir.

This eurytomid, a chalcidoid, the most abundant, most effective, and most adapted to its host of the primary parasites of Pissodes, was first noted in 1912 and was named in 1916. It is widely distributed over the entire range of its host. The description may be summarized as follows:

Adult: Black, dull on the sculptured thorax, glossy on the polished abdomen; with bright red eyes; about 4 to 5 mm. in length.

Egg: A cylindrical ellipsoid, stalked at both ends; yellowish, with fine black pubescence; .51 x .18 mm.

Larva and pupa: Creamy-white; typical, show no unusual characters.

This parasite emerges shortly before, and at, the optimum time for parasitization, which is when the weevil larvae are beginning to pupate. It was clearly established that Graham's surmise that *Eurytoma* has a generation on an alternate host prior to parasitizing *Pissodes* is not supported by the observations made in this study. A small proportion, about 4 per cent, emerge in August of the current year but these summer emergents cannot parasitize the weevil, which, itself, is emerging at this time.

The courtship tactics lasted about five minutes but copulation consumed only a few seconds. The duration of oviposition, which occurred soon afterward, was about 22 minutes. In this act, the ovipositor sheath was first placed at the site and the ovipositor, used as a single piece and operated by movements of the abdomen as a whole, was then inserted in the leader. (The ovipositor issues from the anterior of the abdomen).

Because *Eurytoma* is restricted to the pupal cells of *Pissodes* and is almost entirely limited to slender leaders (about one-fourth to three-eights of an inch), and because the ovipositor was found to be sufficiently long to reach the cells in these leaders, it is inferred that the weevil larva or pupa is parasitized in its cell and that very probably the ovipositor penetrates, either directly through the wood, or through the chip-plugged entrance shaft of the pupal cell. It is very difficult to bring about actual oviposition in captivity. Dissection of 20 females yielded ova counts of five to seven mature eggs (about .74 x .22 mm.) in six cases; the largest number of ova counted was 31 but it is probable that the number may be greater.

The parasite larva completely consumes its host in about ten days and, commonly at first, doubles its size in two or three days. The pre-pupae remain quiescent in the weevil pupal cell until the following spring, or for ten to eleven months. The adults bore directly outward through the xylem of the leader and very rarely is an individual stuck.

The longevity of the parasite at room temperature without food was five to seven days; fed with honey and water, which both sexes eat readily, the males averaged about 16 days and the females about 26.

Eurytoma is considered to be highly adapted to its host on the following grounds: (a) The peak of emergence is very close to the optimum time for parasitization while the potential oviposition period is about a month; (a) definite courtship is practised indicating general specialization; (c) the eggs possess attachment stalks; (a) but one egg per host is laid; (e) the relative security from birds afforded the prepupae by their position in the innermost weevil pupal cells.

The effectiveness of *Eurytoma* was about six per cent of the available mature weevil larvae in 3,009 weeviled leaders.

Lonchaea corticis Taylor

This lonchaeid, order Diptera, which was second in abundance in the total material (though third in Massachusetts), and which is an important primary parasite of *Pissodes strobi,* was named and described in 1928 in the course of this study. It is very probably the same species mentioned as *L. rufitarsis* (*polita*) Macq. by Graham and as *L. laticornis* Mg. by MacAloney from similar material. Though this fly is facultatively parasitic and is often well parasitized in turn by a small pteromalid, *Pleurotropis* n. sp., it is well entitled to its rank. *Lonchaea* is well distributed over the entire range of its host. The description may be summarized as follows:

Adult: A dark steel-blue muscoid fly about 3.5 to 4 mm. long; the abdomen may be elongate, oval, or almost round, but usually is broadly tapered at the posterior.

Egg: An elongate, slightly curved body sharply pointed at one end, rounded at the other; pearly white, appears finely striated; .72 x .18 mm.

Larva and puparium: Typical of unmodified muscoid Diptera.

The emergence curve from early May to mid-July shows markedly that the males precede the females by two to four weeks. The summer emergence is about equal to the spring emergence or even greater; these flies cannot parasitize *Pissodes* because of the latter's maturity but there are indications that they invade the burrows of divers bark beetles.

Lonchaea would not copulate or oviposit in captivity but in nature the oviposition period is apparently coincident with that of the weevil. From 6 to 25 eggs, pointed end up, are placed in the feeding and oviposition cavities made in the leaders by *Pissodes.*

If these eggs hatch simultaneously with those of the weevil, the maggots and grubs mine the shoot together; the frass-feeding dipterous larvae consume many young weevil larvae but most of the early stage grubs would have perished anyway. If the eggs hatch considerably later than do those of *Pissodes,* the maggots feed largely on frass and a few starved stragglers of the weevil ring since the mature grubs and pupae in the cells are rather well protected by the densely packed wood chips that plug the entrance burrows. If, however, as is more often the case, the eggs hatch about a week later than do those of the weevil, the maggots not only feed on frass and immature weevil larvae, but they overtake the weevil ring about at the time of its disintegration, consume many mature grubs, and are able to invade many weevil pupal cells before these cells are entirely completed. Under these last conditions, *Lonchaea* reaches its maximum effectiveness.

Laboratory tests have shown that young *Lonchaea* larvae fed on frass exclusively completed their development and formed puparia in nine to twelve weeks. Similar tests with maggots fed on weevil larvae exclusively have shown that they attain full size in about ten days. Tests with young fly larvae in cultures with both frass and weevil larvae have shown that about 70 per cent of the total reach maturity in five weeks. Apparently, weevil larvae are sought out and consumed in preference to frass. While it should not be assumed that the August emergence, because of their early appearance, represent the only flies that have eaten mature weevil larvae (since puparia formed in August may winter over), yet these summer emergents do represent, very probably, those maggots which ate the most weevil protein. Under laboratory conditions, with all the weevil larvae they could eat, a maximum of nearly one host per *Lonchaea* larva was consumed in an eight day period. A count of 679 weevil pupal cells which contained 1,347 *Lonchaea* puparia gives, under natural conditions, an average host consumption of about one-half of a grub per *Lonhcaea* larva. If the fly is abundant and if the eggs have hatched at the optimum time, the entire weevil ring may be destroyed. *Lonchaea* is suspected of consuming hymenopterous parasites in addition for this, though not proved, is indicated by the singular lack of other parasites in leaders where the fly is numerous.

At room temperature, flies without food lived about two weeks; those fed with honey and water, which they tended to gorge and which may not be the best food for them (though failure to copulate on this ground is not held likely), lived about a month; iced stocks lived barely longer.

This parasite might be regarded as a predator but it is classified otherwise here because of a close adaptation to, and dependence on, the habits of *Pissodes.* Its effectiveness was about five and one-half per cent of the mature weevil larvae in 3,009 weeviled leaders. In the 2,602 Massachusetts leaders considered separately, the effectiveness was about two and one-half per cent.

Microbracon pini Mues.

This braconid, third in abundance (second in Massachusetts), third in importance, and which has the potentialities of a partial second generation on *Pissodes,* was obtained relatively recently and was named in 1925. It appears to be well distributed over the range of its host with the possible exception of the southern portion of the white pine zone; it is most numerous in New England. The description may be summarized as follows:

Adult: The general coloration includes a black head and thorax and a brown abdomen with yellowish-brown bands at the sutures; size about 2.5 to 4 mm.; a considerable variation in size between the sexes exists, all dwarf individuals are males.

Egg: An elongate, usually banana-shaped body tapered at one end and rounded at the other; pearly to a pale creamish-white; .81 x .18 mm.

Larva: Antennae are characteristic of all instars observed, these become smaller in proportion with successive moults; pale whitish, globular bodies in the posterior two-thirds of the abdomen, visible through the body wall, are common in all but the nearly mature larvae; general color, yellowish.

Pupa: Cream-colored; no unusual characters.

This parasite emerges considerably before the optimum time for parasitization; many partly-grown weevil larvae are parasitized. This early emergence and usual wait of two to four weeks before oviposition suggests the interesting possibility that *Microbracon* is in the evolutionary process of changing hosts. The proportion of summer emergents was about 37 per cent of the yearly total and, because of the reaction to the weeviled leaders, the presence of mature eggs in the ovaries, and the suitable stage of the late-developed individuals of the host, a partial second generation is indicated.

Copulation, which occurs immediately upon emergence, is very rapid and is not preceded by any courtship. Under natural conditions, oviposition is delayed by the necessary waiting; in the laboratory, females kept till the optimum time and then mated did not oviposit immediately as did those mated before storage. The duration of oviposition, which includes the phases of selection of a site, subcortical exploration, stinging the host, and extrusion of the eggs, as observed, ranged from 4 to 34 minutes. In this act, the ovipositor sheath was used as a brace when the ovipositor was inserted; the two pieces of the latter organ were moved separately, one piece alternating with the other in a rapid up and down motion; this motion facilitates the penetration of the elastic skin of the weevil larva and accompanies the passage of the eggs.

From one to five eggs are laid per host, which is temporarily paralyzed. The eggs are easily dislodged and it is quite probable that there are instances where the larvae just hatched encounter and consume individuals other than the ones for which they were intended. Based on 948 cocoons counted in 431 weevil pupal cells, the average number of successful parasite larvae per host is about 2.2. Oviposition in captivity, while more easily obtained than with any of the other species studied, was, nevertheless, probably considerably less than would have occurred under natural conditions. Dissection of 20 females yielded ova counts of five to twelve nearly mature eggs in nine cases; the number of immature ova was considerable; five summer emergents, upon dissection, showed four and nine mature eggs in two cases.

The parasite larva consumes its host in less than one week; it was observed that a single larva could not consume an entire weevil grub. Pupation requires about a week and the parasite may emerge the same season or winter as a pupa in a cocoon. When the adults emerge, they utilize the entrance burrows of the weevil.

The longevity of *Microbracon* at room temperature, fed with honey and water, which both sexes eat readily, averaged about 11 days for males and 14 for females; in an ice-chest stocks were kept as long as needed, or over two months.

Microbracon is considered relatively unspecialized in its adaptation to its host on the following grounds: (a) The peak of emergence occurs considerably in advance of the optimum time for parasitization; (b) the eggs, which are not attached, are easily dislodged by the temporarily paralyzed host; (c) a lack of discrimination in placing eggs is shown, since empty frass and dead larvae may receive them; (d) the number of eggs laid per host is almost always more than one and may be five; (e) the outermost weevil pupal cells, where the large majority of cocoons occur, are in the position most vulnerable to birds.

The effectiveness of this parasite was about two and one-half per cent of the mature weevil larvae in 3,009 leaders; in Massachusetts alone, nearly three per cent of the mature larvae were consumed.

Eupelmus pini Taylor

This eupelmid, a chalcidoid, fourth in abundance, and not particularly important as a parasite of the white-pine weevil, was named and described in 1927 in the course of this study. It has been obtained in Massachusetts, Connecticut and New York only.

Adult: The general coloration is greenish-purple with iridescence; with purplish eyes. The abdomen is held tilted up in a characteristic manner; size, about 3 to 4 mm.

Emergence takes place in May or June depending upon the season. The parasite readily went through the preliminaries of oviposition but no eggs were found, either near, on, or in, the weevil larvae, nor did any of the presumable host appear paralyzed when the leaders were examined immediately after the acts of apparent oviposition. Though the members of the genus, *Eupelmus,* are catholic in their tastes, often parasitizing Hymenoptera, Coleoptera, and Lepidoptera, it is believed in this case that *Eupelmus pini* is parasitic on *Pissodes,* since (1) the preliminaries of oviposition occur at the optimum time for parasitization, (2) an individual taken from a pupal cell in the field was reared to an adult, and (3) Barnes reports breeding this species from weevil larvae. Because of its size, it is assumed that a one-parasite-per-one-host relationship exists.

No summer emergence was obtained and the total effectiveness based on the spring emergence alone, was about .87 per cent of the mature weevil larvae in 3,009 leaders, and virtually one per cent in the 2,602 Massachusetts leaders.

Rhopalicus pulchripennis (Cwfd.)

This pteromalid, a chalcidoid, fifth in abundance and not numerous enough to be an important primary of *Pissodes,* was named and described by Crawford in 1912 as *Spintherus pulchripennis.* Gahan has found *Rhopalicus americanus* Gir. (1916) to be a synonym and placed Crawford's species in the genus *Rhopalicus.* Distribution records include N. H., Mass., N. Y., Mich., and Mont.

Adult: The general coloration is more or less a vivid green, iridescent; the bright red eyes are distinctive; size, about 4 mm. The males are rare.

Egg: A creamy, torpedo-shaped body about .60 mm. long, .18 mm. at greatest width, .12 mm. wide at the ends; it possesses two light, transverse bands.

Larva and pupa: Yellowish to creamy-white; possess no unusual characters.

Rhopalicus emerges during June or earlier depending on the season. About three quarters of the total emergence occurs in the summer, and, while no females of this group were observed to oviposit, the presence of mature eggs in the ovaries and the time of emergence make a small second generation on *Pissodes* a possibility; those females which do not emerge earlier than late July or August may be eliminated from this possibility.

Copulation was never observed (parthenogenesis is probable) but oviposition was noted many times and the female in each case was meticulous in selecting a site. The eggs (.16 to 1 per female per day were produced in the cages) hatch in three to seven days. Usually, but not always, but one larva to a host, which commonly may not be entirely consumed, was found in the leaders. Larval development required seven to ten days for completion, pupal development was complete in about eight days. (All the stages reared through *in vitro* became summer emergents.) It is considered probable that those individuals which winter over, do so as naked prepupae. Dissection of the ovaries of ten females showed five or six mature eggs in four cases; the summer females yielded ova counts of four and five mature eggs in two out of three females.

In the 3,009 leaders, the effectiveness was about .73 per cent of the mature weevil larvae.

Coeloides pissodis (Ashm.)

This braconid, sixth in abundance and so few in numbers that its importance is negligible, was named and described as *Bracon pissodis* by Ashmead in 1888. Viereck's *Habrobraconidea bicolor-ipes* is a synonym. Distribution records include New England, New York, and Pennsylvania.

Adult: The black head and thorax, orange abdomen, and long antennae are distinctive; size, 4 to 5.6 mm.

Egg: A pearly white body tapered and translucent at the narrow end; 1.56 x .18 at wide end, .08 mm. at narrow end.

Larva: Markedly resembles that of *Microbracon pini* but proportionately larger; creamy-white to yellowish.

Pupa: Creamy-white, with large and conspicuous ovipositor.

Coeloides emerges from mid-June to mid-July, or earlier, depending on the season; a summer emergence, nearly half of the total, occurs from late July into August but, presumably, these females cannot parasitize the weevil.

Copulation occurs immediately upon emergence and oviposition a few days later. Based upon limited data, the hatching time of the egg and development of the larva are very rapid. In one case, all stages from the deposition of the egg by an adult to the pupal stage of the next generation took place in seven days (*Microbracon* passed through the same stages in a minimum of eleven days). Apparently but one parasite develops from a single host.

Oviposition in posture and the like is essentially similar to that in *Microbracon*; the duration of the act, as observed, was about 25 minutes. The weevil larvae are severely stung, paralysis is complete and, apparently, death may ensue. There are indications that more larvae are stung than are oviposited upon and, if this supposition is correct, then *Coeloides* is more effective than its numbers alone would indicate. In one cage, three females in seven days produced two pupae and nine larvae; in another, eight in three days produced two of each. Dissection of the ovaries of five females showed, in two cases, 15 and 2 mature eggs.

Coeloides adults at room temperature, fed with honey and water, which they readily ate, lived an average of between 24 and 25 days, a grater age than attained by any of the other hymenopterous parasites under similar conditions.

The effectiveness, based on one parasite per host, was found to be about one-quarter of one per cent of the mature weevil larvae in the 3.009 leaders.

Calliephialtes nubilipennis (Vier.)

This ichneumonid, seventh in abundance, and obtained in so limited a quantity that it is, without doubt, a negligible factor in the natural control of *Pissodes,* was named and described as *Exeristes nubilipennis* by Viereck in 1912. Distribution records include Maine, Mass., Pa., Mich., and Mont. *Calliephialtes* is listed as a primary of the weevil because such is the opinion of Cushman.

The species copulated rapidly upon emergence, which was in May and early June, and readily assumed the attitude of oviposition; no eggs, however, were found, either near, on, or in, the weevil larvae and no cases of paralysis of the presumed host were noted. A characteristic habit is the extreme restlessness displayed in the various cages and containers.

The effectiveness of the 18 individuals, if rated on the basis of one parasite per host, as the large size would indicate, was only about one twentieth of one per cent of the mature weevil larvae in the 3,009 leaders.

Spathius sp.

This braconid, very close to *S. brachyurus* Ashm., was obtained only in the summer emergence of 1928 from material from Milton, Mass. Records, which list only coleopterons as hosts of this genus, support the assumption that this species is a primary of *Pissodes,* as *S. brachyurus* is reported to be. Because of its rarity, this species cannot be considered of interest from a purely economic standpoint.

Pleurotropis n. sp.

This small black eulophid, a chalcidoid, is the most abundant secondary parasite of *Pissodes* and has *Lonchaea corticis* Taylor for its host. It is widely distributed over the entire range of the white pine weevil.

There is but one generation a year and its emergence, which extends from May to mid-July, roughly coincides with that of its host. It is probable that *Pleurotropis* oviposits in or on nearly mature *Lonchaea* larvae, which are probably consumed in the puparium, and that the parasite then hibernates as a larva or pupa in the host puparium. A count of 82 exit holes, about .5 mm. in diameter, over 27 parasitized puparia gives an average of about three parasites per host. It has been estimated that the parasitism of *Lonchaea* by this species may rise as high as 50 per cent. It was also estimated that if each individual parasite represents, indirectly, about one-sixth of a weevil grub, then Pleurotropis may be held to account for about one-half of one per cent of the mature weevil larvae in the 3,009 leaders considered.

Eucoila sp.

This cynipid, which is a not uncommon emergent from weeviled coniferous leaders, is classed by Gahan as parasitic on Diptera, which thus makes it a probable parasite of *Lonchaea corticis* Taylor. It is well distributed over the northern part of the white pine belt. The emergence is in July or earlier, depending on the season. Based upon limited data, the summer emergence is about equal to the spring emergence. *Eucoila* is not sufficiently numerous to be an important factor in the bionomics of its assumed host, though a full second generation would be quite possible.

Hemiteles humeralis Prov.

This ichneumonid, in the opinion of Cushman, is a secondary of *Pissodes;* members of the genus are commonly parasites of other hymenopterous parasites. Its great rarity (only two females obtained from a total of nearly five thousand leaders in three years) deprives it of importance from an economic viewpoint.

A list of parasites reported from *Pissodes strobi* or from weeviled material, obtained in small quantity or singly by other investigators but not encountered in the course of this study, includes nine braconids, five ichneumonids, one ceraphronid, one diapriid, one chalcid, three eurytomids, one encyrtid, four pteromalids, and one eulophid, a total of 26. This list should not be considered as a supplementary list of parasites of the white pine weevil since all parasitic forms which emerge from such material are not necessarily connected with *Pissodes.* In addition to the above, there is a reference in the literature to *Compsilura concinnata* as a parasite of *Pissodes.* The validity of this single record, which is attended by unusual circumstances, is highly questionable and it would seem much more probable that this well known fly in this instance emerged from a lepidopterous host, of which there are a number in such material.

(Two species of *Scleroderma* have been reared from immature stages of the weevil in the laboratory cultures of other workers, and the possible usefulness of this abundant source of food for parasites of this type is suggested.)

A total of 19 species of parasites, which, according to Gahan and Cushman, have no connection with *Pissodes,* or for which evidence is lacking, was obtained incidentally in this study. The list includes two braconids, nine ichneumonids, one diapriid, one eurytomid, two eupelmids, three pteromalids, and one eulophid.

Predators

In this study, those forms which were predators upon *Pissodes* included several clerids and one moth, a pyralidid, all predacious in their larval stages. Of these, *Hydnocera verticalis* Say was the most abundant (524 from Mass., 2 from Pa., and 1 from Conn.). Laboratory tests with this clerid gave an average of about one mature weevil larva consumed per predator; this average may be low for immature weevil larvae. On such a basis, *Hydnocera verticalis* consumed about one and one-half per cent of the mature weevil larvae in 3,009 leaders.

Placopterus thoracicus Oliv., another clerid, was second in abundance (332 in Mass., and 1 from Pa.). No tests were made with this predator but since it is several times larger than *Hydnocera,* a "one-per-one" estimate would seem conservative. On this basis, *Placopterus* consumed about one per cent of the mature weevil larvae in the 3,009 leaders. Several other clerids, which belong to genera known to be characteristically predacious on coleopterous borers in wood, were obtained in small numbers and are listed. The clerid observed by Graham was not obtained and the early reports (1885, 1890) that "the young" of Tenebrionidae feed on *Pissodes* were not (and never have been) substantiated.

The lepidopteron, *Dioryctria* n. sp., was the third most effective predator. This caterpillar, which feeds on frass left by the weevil, apparently manifests a disposition to seek out weevil grubs as well as consuming them upon accidental encounters. Since the spring generation emerges at the time of, or shortly before, initial weevil oviposition, the caterpillars produced by the adults of the spring emergence are the only ones enabled to prey on *Pissodes.* A count of 11 tunnels showed a total of 53 invaded weevil pupal cells, or an average of about five mature weevil larvae consumed per caterpillar. On this basis, *Dioryctria* destroyed about one-quarter of one per cent of the mature weevil larvae in the 3,009 leaders.

Nematodes

Nematodes are common under the elytra of adult weevils, especially at the wing bases, and in the damp frass behind the weevil ring. One nema was determined by Cobb for Barnes as a *Diplogaster* sp., while a species obtained in this study was determined by Steiner as *Rhabditolaimus* n. sp. Steiner stated that it was very probable that the same nemas of the frass are carried around by the adult weevils and also that they over-winter under the elytra of the curculio. European species of *Rhabditolaimus* and *Diplogaster* are found in the burrows of *Ips typographus* and *Hylobius abietis,* where they live in a certain type of symbiosis. Barnes found a few undetermined nemas in the adipose tissue of weevil larvae and in the bursa copulatrix of an adult female. The hundreds of nematodes observed in the course of this study apparently do not affect the vigor of Pissodes adults, at least not during the mating and oviposition periods, while it would seem that if the weevil larvae are parasitized internally (no external parasitism was noted) their development would be adversely affected. Such does not seem to be the case and there is no evidence that the large number of young weevil larvae which fail to mature, owe their death to nemas. In conclusion, nematodes are not considered to be an important factor in the bionomics of *Pissodes.*

III. *A Discussion of the Feasibility of Applied Parasite Control of Pissodes*

Of the eight primary parasites obtained in the course of this study, but three are sufficiently effective to merit discussion in connection with the possibility of applied parasitism. These are *Eurytoma pissodis* Gir., *Lonchaea corticis* Taylor, and *Microbracon pini* Mues., with about six, five and one-half, and two and one-half per cent effectiveness, respectively. Based upon emergence counts, parasitism and predatism together accounted for about 19 per cent of the mature weevil larvae in 3,009 leaders; based upon dissection of these leaders, the maximum ascribed to parasitism and predatism was about 27 per cent; the highest maximum in the small lots, really selected for a high parasite content, was about 59 per cent. It is thus indicated that the native parasites of this native pest do not have the high degree of effectiveness to be sought for in parasites which are selected for applied biological control.

In addition to the data secured in this study, the potentialities of the three primaries named were analyzed and "measured" with the aid of Smith's outline, which includes seven points for consideration in deciding upon the practicability of artificial propagation of parasites and the feasibility of their use as agents of control. When this was done, it was concluded that, under present conditions and with our present knowledge of the host and the parasites, control of the white pine weevil by the applied parasitism of its *native* parasites would not be feasible.

The question of the feasibility of the applied parasitism of introduced parasites must remain unanswerable until the subject has been investigated. Two regions which merit study in this respect are the western United States, where there are three species of *Pissodes* which mine coniferous leaders, and Europe, where several species of the genus also mine, more or less consistently, all parts of such conifers as *Pinus, Picea, Abies,* and *Larix.* A list of the parasites (*e.g.*, 31 species from *P. notatus*) which have been reported from European *Pissodes* material is given. Without doubt, many of this list are not directly connected with the weevil to which they are ascribed, but, also without doubt, there are unrecorded species to be discovered. There is at least a possibility that one or more of these exotic parasites might prove a valuable addition to the present known parasites of *Pissodes strobi*. It would seem that it is a possibility which should be examined.

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EXPLANATION OF PLATES

Plate I.

Fig. 1. Feeding and egg-laying punctures made by *Pissodes strobi* at the tip of a leader of white pine.

Fig. 2. Section of a weeviled leader which contained parasites. At the left may be seen the naked prepupa of *Eurytoma pissodis*, while in the center is a cluster of three cocoons of *Microbracon pini.*

Plate II.

Fig. 3. An early instar larva of *Eurytoma pissodis* feeding upon a white pine weevil larva which had just completed its pupal cell.

Plate III.

Fig. 4. Adult female of *Eurytoma pissodis* Girault.

Fig. 5. Stalked egg of *Eurytoma pissodis.* About .5 x .2 mm.

Fig. 6. Sketch of an early instar larva of *Eurytoma pissodis* consuming its host.

Fig. 7. Lateral aspect of prepupa of *Eurytoma pissodis.*

Fig. 8. Pupa of *Eurytoma pissodis.*

Fig. 9. A sketch to illustrate the position of the ovipositor in *Eurytoma pissodis.*

Fig. 10. A sketch of *Eurytoma pissodis* in the attitude of oviposition. It may be noted that the ovipositor issues from the anterior of the abdomen, which is more or less typical of chalcidoids.

Fig. 11. A sketch of the pattern of the spiracles of the larvae of the dipterous parasite, *Lonchaea corticis* Taylor.

Plate IV.

Fig. 12. Adult female of *Microbracon pini* Muesebeck.

Fig. 13. Egg of *Microbracon pini.* About .8 x .2 mm.

Fig. 14. Ventral aspect of an early instar of *Microbracon pini.*

Fig. 15. Ventral aspect of a *Microbracon pini* larva one instar later than the one shown in Fig. 14.

Fig. 16. Lateral aspect of an intermediate stage larva of *Microbracon pini.*

Fig. 17. Full grown larva of *Microbracon pini* in latero-ventral view.

Fig. 18. Diagrams of the attitude of the abdomen of *Microbracon pini* during oviposition. The lower figure shows the insertion of the ovipositor, the upper, the ovipositor fully inserted; in this latter figure, an egg is shown in the act of being laid.

Fig. 19. Adult female of *Eucoïla* sp.

Fig. 20. Egg of *Rhopalicus pulchripennis*. About .6 x .2 mm. (.1 mm. at tips).

PLATE V.

Fig. 21. A first instar larva of *Rhopalicus pulchripennis* (Cwfd.) on its host.

Fig. 22. Mature larva of *Rhopalicus pulchripennis*.

Fig. 23. Pupa of *Rhopalicus pulchripennis*.

Fig. 24. a. Adult female of *Lonchaea corticis* Taylor; b. The antenna, a specific character.

Fig. 25. A young larva of *Lonchaea corticis* leaving the skin of a consumed weevil larva. Two other dipterous larvae, not shown, had participated in this meal.

Fig. 26. Adult female of *Pleurotropis* n. sp., a parasite of *Lonchaea corticis*.

PLATE VI.

Fig. 27. Adult female of *Coeloides pissodis* (Ashmead).

Fig. 28. Egg of *Coeloides pissodis*. About 1.5 x .2 mm.

Fig. 29. Lateral aspect of a mature larva of *Coeloides pissodis*.

Fig. 30. A sketch of a breeding cage found very successful for small lots of weeviled leaders. The parasites are readily removed in the jar, while another jar is slipped into the sleeve. Description in text.

Fig. 31. Pupa of *Coeloides pissodis*.

PLATE VII.

Fig. 32. Mature male of *Calliephialtes nubilipennis* (Viereck).

Fig. 33. Sketch of *Calliephialtes nubilipennis* about to insert the ovipostor. It may be noted that the ovipositor is braced against the venter of the thorax.

Fig. 34. Adult female of *Spathius* sp. (close to *S. brachyurus*). The antennae are much shorter than is typical of the members of the genus seen.

Fig. 35. Adult female of *Hemiteles humeralis* Provancher.

Fig. 36. Mature caterpillar of *Dioryctria* n. sp. which is facultatively predacious upon *Pissodes* larvae.

PLATE VIII.

Fig. 37. Graph of the spring emergence of *Eurytoma pissodis* in 1928.

Fig. 38. Graph of the spring emergence of *Lonchaea corticis* in 1928.

PLATE IX

Fig. 39. Graph of the spring emergence of *Microbracon pini* in 1928.

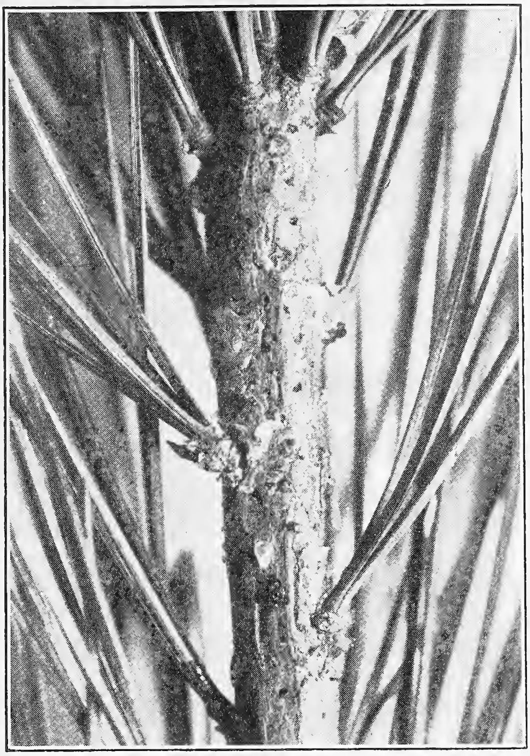
Fig. 40. Graph of the emergence of *Eupelmus pini* Taylor in 1928.

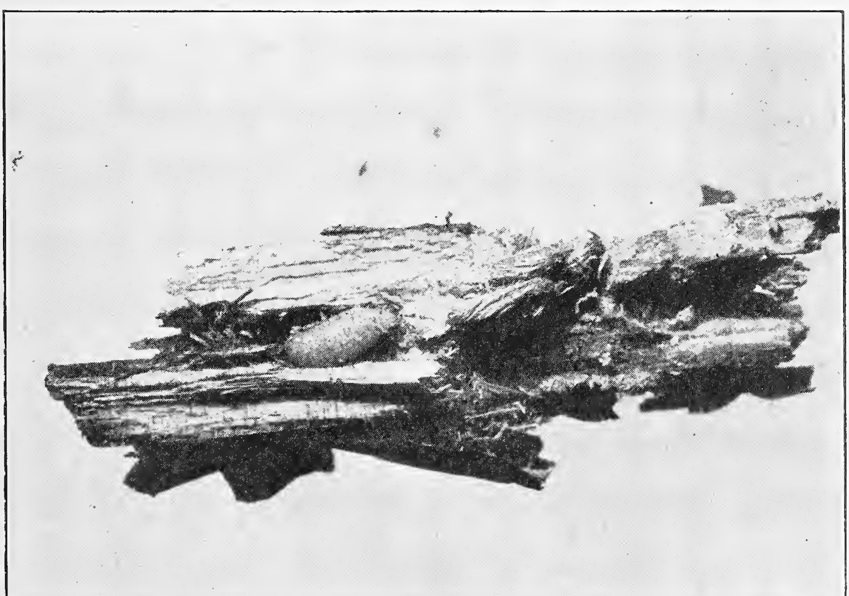
Fig. 41. Graph of the spring emergence of *Rhopalicus pulchripennis* in 1928.

PLATE X.

Fig. 42. Graph of the emergence of *Pleurotropis* n. sp. in 1928.

Fig. 43. Graph of the spring emergence of *Eucoila* sp. in 1928.





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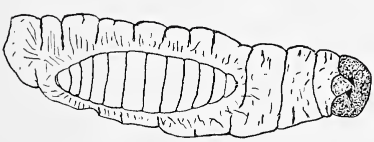

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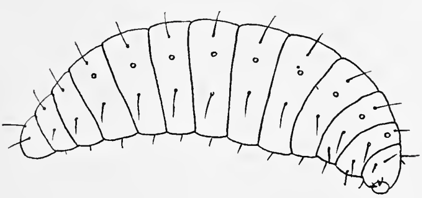

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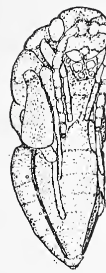

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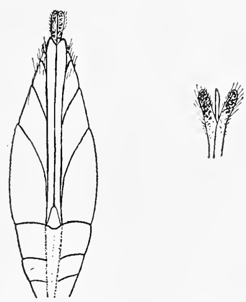

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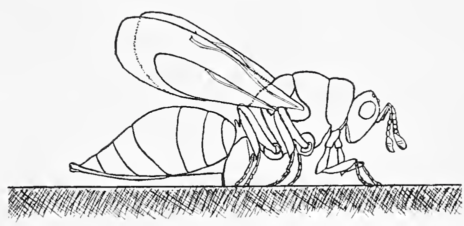

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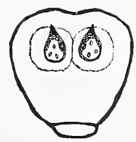

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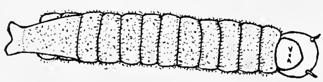

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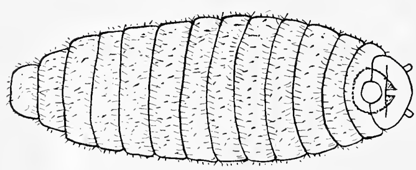

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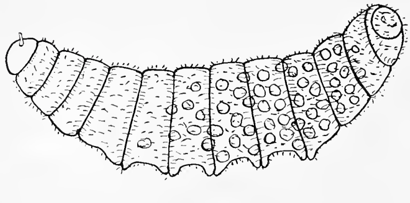

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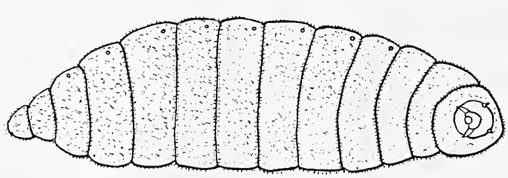

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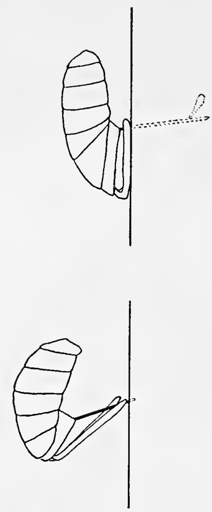

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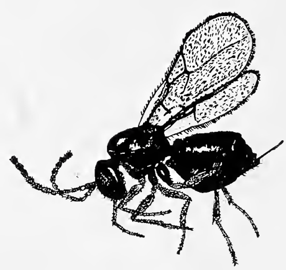

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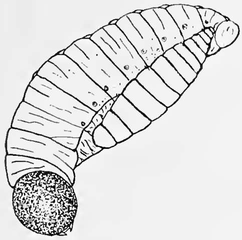

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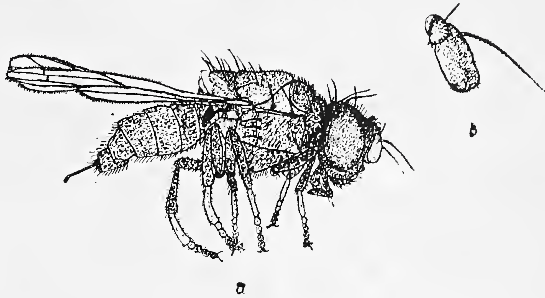

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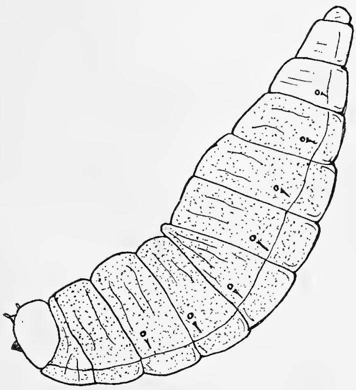

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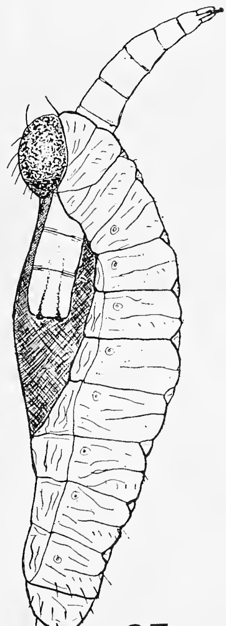

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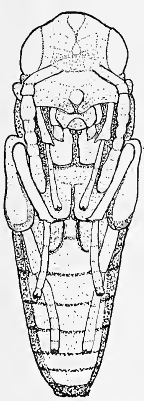

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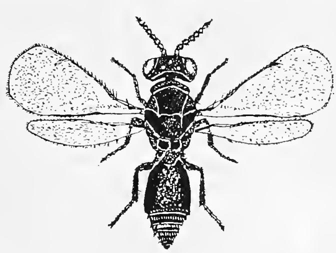

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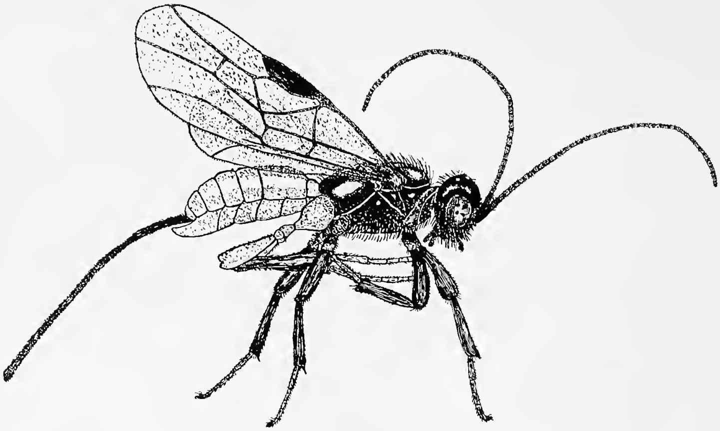

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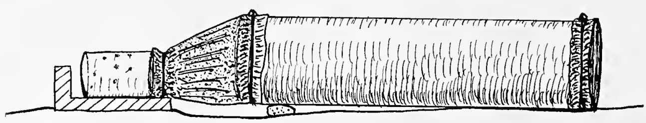

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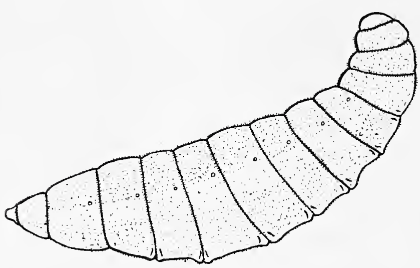

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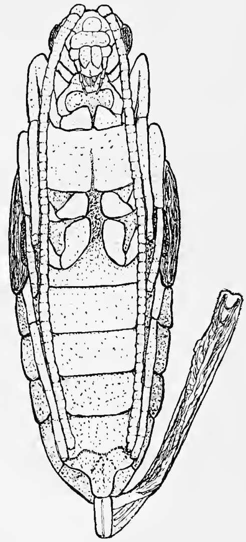

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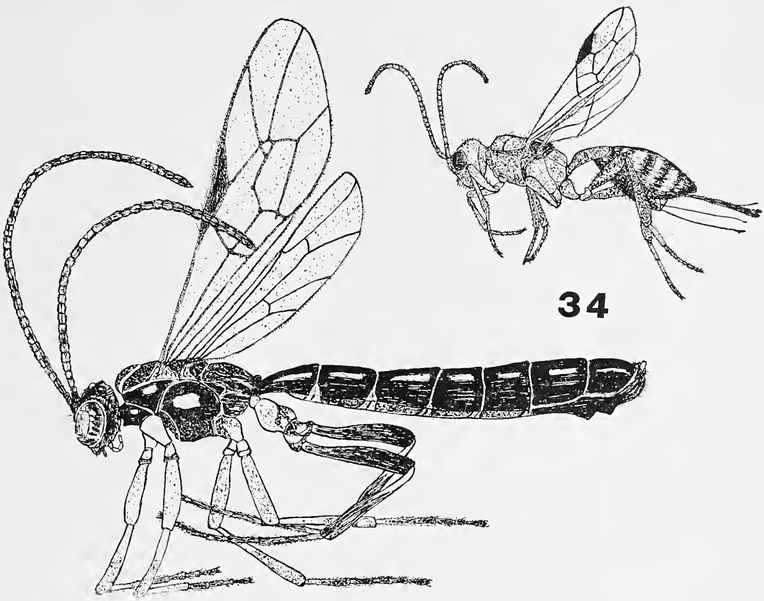

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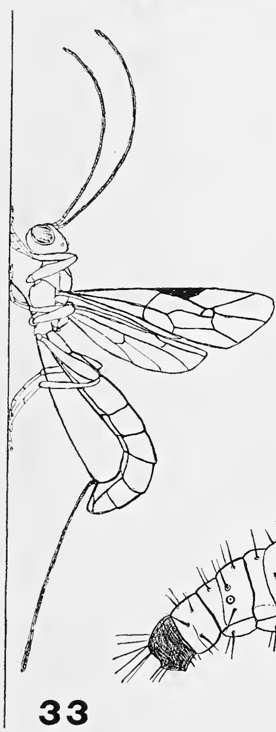

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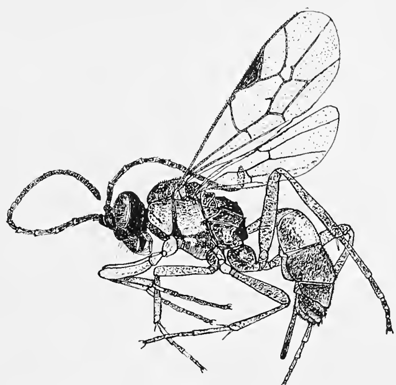

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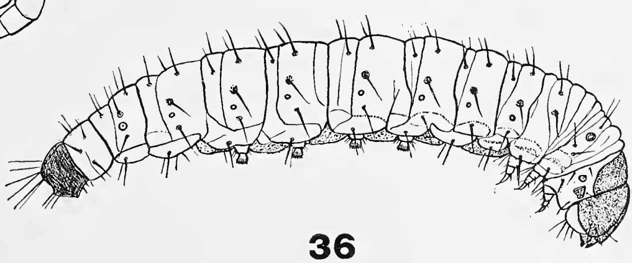

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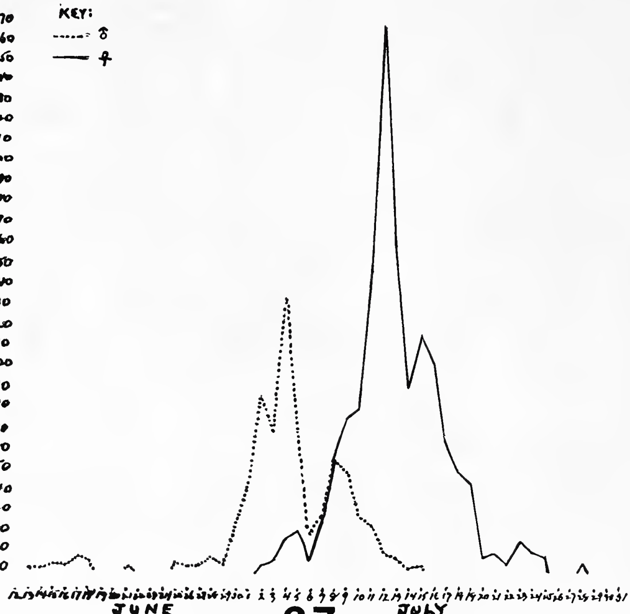

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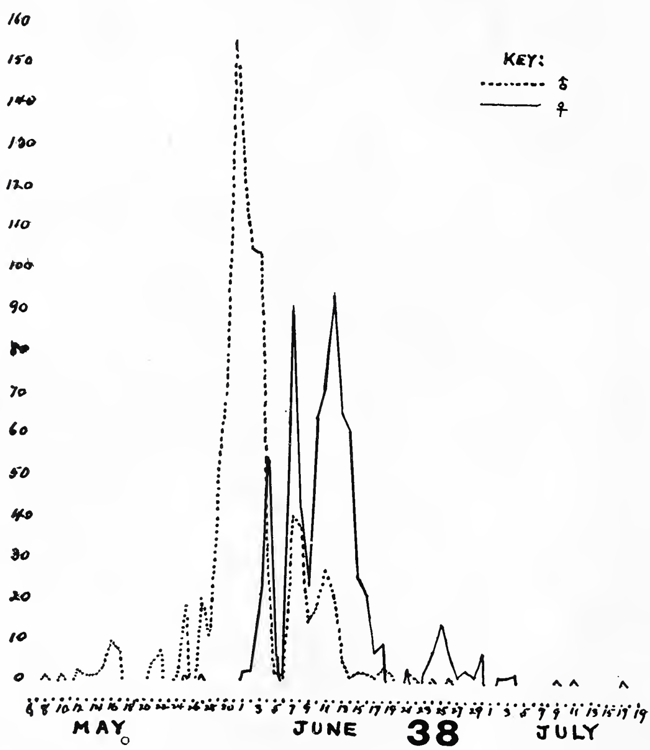

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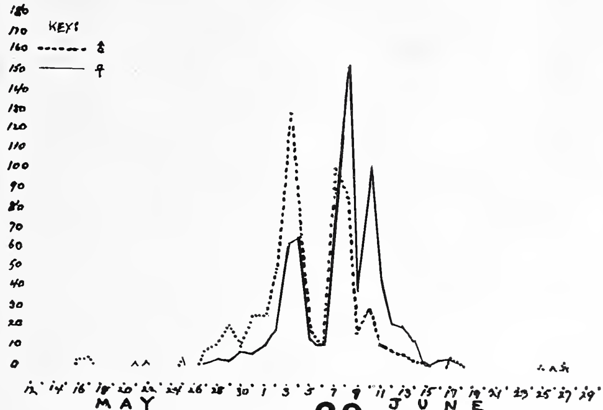

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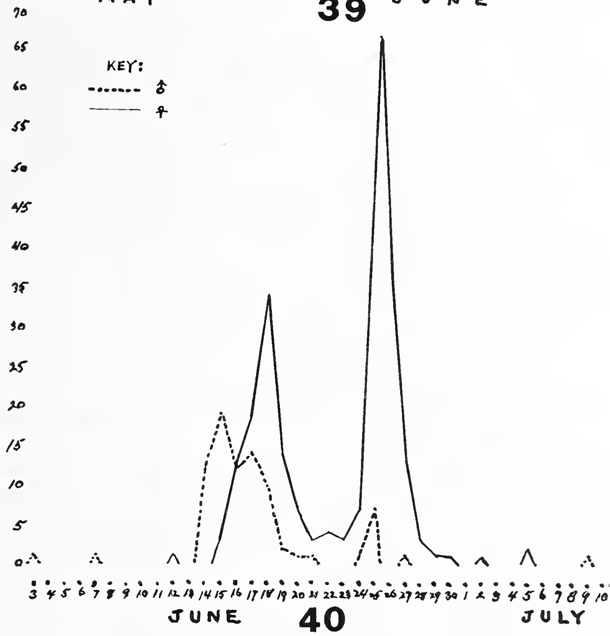

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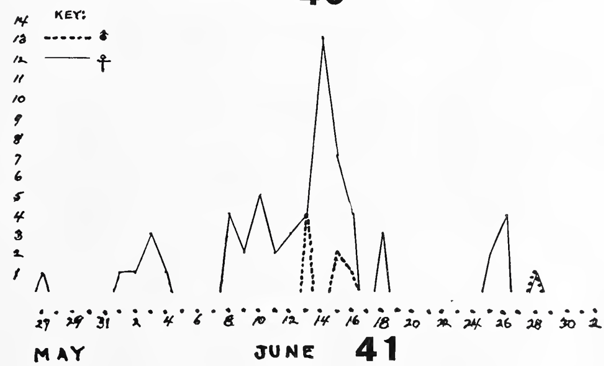

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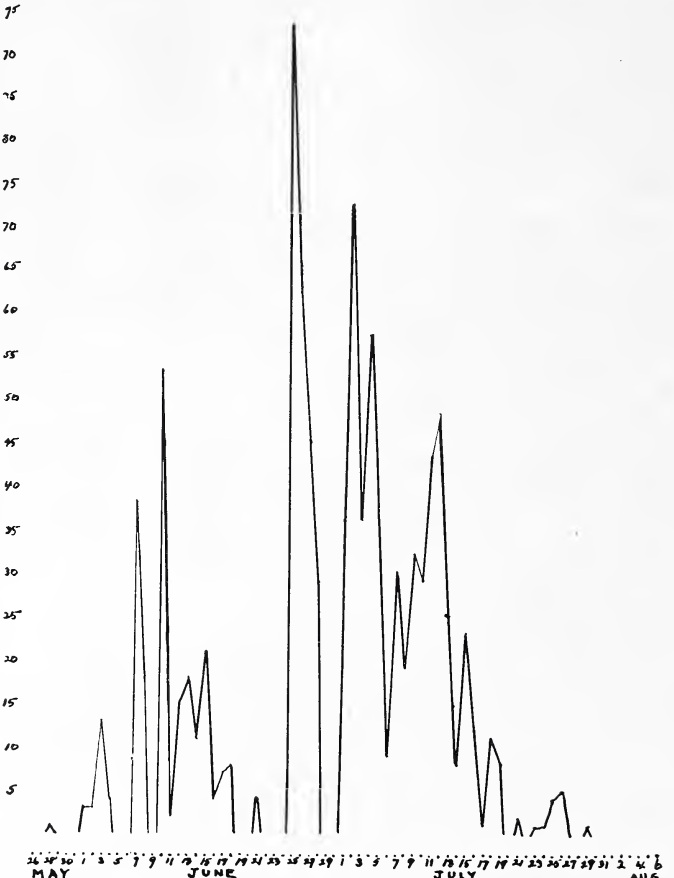

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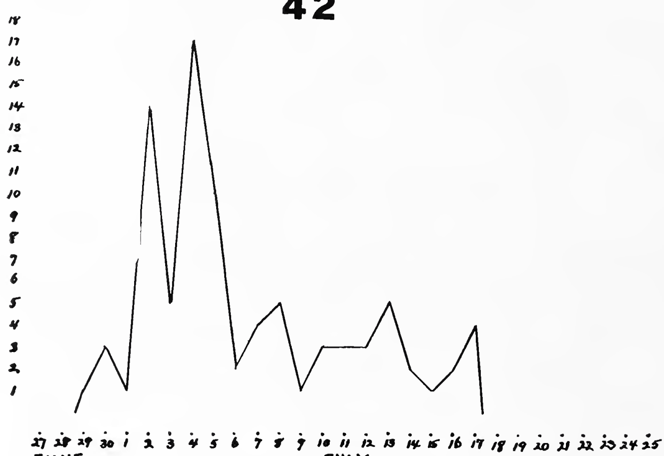

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A Monographic Study of the North American Species of Euscelis and Allied Genera. (Homoptera-Cicadellidae)*

By

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INTRODUCTION

After a careful examination of all material available for study, an attempt has been made to arrange the species phylogenetically according to structural relationships, using all possible characters. A detailed study has been made of the internal genitalia in an effort to correlate these structures with the external structures. In as far as possible type material has been examined and synonyms have been removed from specific ranking. Correlation between the numerous field observation records of several workers and the laboratory examination of material has been made in an attempt to determine the food habits, the distribution, and the ecological habitats of the species.

ACKNOWLEDGMENTS

This study has been made possible only through the assistance of many workers in this particular field. The work has been completed under the direction of Dr. D. M. De Long who has placed

* Contribution no. 97 from the Department of Zoology and Entomology, Ohio State University.

at the author's disposal his private library and collection. To him the writer is greatly indebted for many helpful suggestions and criticisms. Professor Herbert Osborn has likewise aided in the carrying on of this work and has also placed at the author's disposal his private library and collection containing a number of types. Dr. E. D. Ball has furnished much valuable material in the form of types and specimens of rare or little known species. In addition he has looked over the manuscript and has offered many helpful suggestions and criticisms. Dr. H. H. Knight has kindly loaned the Iowa State Agricultural College collection containing a number of Osborn and Ball types. Also, Mr. E. P. Van Duzee has furnished valuable material in the form of specimens of several of the more rare species. To these workers the author wishes to express his sincerest appreciation for the much valuable assistance and material so willingly given.

ILLUSTRATIONS

The illustrations which have been used in this study are line drawings to illustrate structures and proportions. For the purpose of making the drawings accurate an ocular micrometer ruled in .05 mm. squares was placed on the diaphragm of one ocular. By superimposing this scale upon the insect structures, all of the exact proportions, curvatures, et cetera, can be transferred with accuracy to coordinate paper. The drawings were then traced upon drawing paper, corrected and inked. The internal genital structures were drawn from ventral and side views in situ.

BIBLIOGRAPHY

Van Duzee's recent catalogue gives numerous references and these will not be repeated here, as it is assumed that any one interested in the group will have access to this catalogue. A brief synonymy is given under each species and also references to recent descriptive literature not included in the Van Duzee catalogue. A general bibliography of the more important papers will be found at the end of this work.

TECHNIQUE

Methods of collecting and preserving leafhoppers will not be discussed here as they are available in a number of works.

In the study of the internal genitalia the following technique has been used. The specimen to be examined is placed ventral side up on a small piece of cork set upon the stage of the binocular.

The abdomen is then carefully separated from the thorax by inserting the point of a small scalpel or needle between the last thoracic segment and the first abdominal segment. The tip of the abdomen is then placed in a small vial of saturated caustic potash and allowed to stand. The length of time the specimen is left in the solution depends upon the degree and color of chitinization. Light and delicate specimens need only be left in for an hour or two while the dark heavy specimens may require several days. Boiling the specimen in caustic potash has proven very satisfactory and it can usually be sufficiently cleared in a few minutes. When cleared the specimen is removed from the caustic solution and placed in a small glass cup containing glycerine and examined. Glycerine proved to be an excellent medium in which to study the specimen, allowing it to be moved about freely. After carefully studying the structures from all angles the drawings were made. In making the lateral view drawings it was found convenient to embed the specimen in glycerine jelly, which held it firm and in the angle desired, yet was perfectly transparent. In cases of doubt as to certain internal characters, the external structures were carefully dissected, thereby fully exposing the internal structures. After drawing, the specimens were placed in small individual vials, carefully labeled, and preserved in 70% alcohol.

THE GENUS EUSCELIS AND ALLIED GENERA

Some confusion exists concerning the oldest tribal name for the group. The genus *Euscelis* was established by Brullé in 1832 and *lineolatus* Brullé has been designated as the type. A detailed study of the external characters and of the internal genitalia of *lineolatus* indicates that *Euscelis* is a valid genus and that a number of American species are very closely related to *lineolatus*. *Athysaninae* must therefore go into synonymy and *Euscelinae* stand as the oldest tribal name for the group.

Osborn and Ball in 1902 divided the genus into four subgenera. Two European genera have recently been erected, Edwards in 1922 proposing the genus *Ophiola* with *striatulus* Fallén designated as the type and the genus *Drylix* with *striola* Fallén as its type. Ball in 1929 made a brief revision of the genus, raising Osborn and Ball's subgenera to generic ranking and erecting the genus *Remadosus* with *magnus* Osborn and Ball as the type and the genus *Exitianus* with *obscurinervis* Stål as the type. All of the groups are recognized as valid genera in this study. Also, a new genus is established and the genus *Amplicephalus* is removed from the *Delto-*

cephalinae and included in the *Euscelinae*. With the idea of a critical examination of these divisions as well as to present keys and illustrations of characters, a revision has been undertaken. A combination of characters is used throughout the work to separate, group, and key the species.

CHARACTERS USED IN CLASSIFICATION

Head

The vertex and frons are the principal head structures used in classification. The vertex is the dorsal area of the head lying between the compound eyes. The proportion of length to width and the angle with which it meets the front are constant and important characters in the separation and the grouping of the species. The vertex merges anteriorly into the frons or front, which, although a separate sclerite and lying in a different plane, is not separated by a definite suture. The vertex may be rather sharply angled with the front, forming a definite margin, or rounded to the front, forming a thick rounded margin.

Thorax

The more important taxonomic structures of the thorax are the pronotum and scutellum. The pronotum covers the entire dorsal surface of the prothoracic segment and no sutures are present to indicate subdivisions.

The large triangular shaped sclerite commonly known as the scutellum is composed of the mesothoracic scutum and scutellum, which are almost completely fused, a transverse groove near the middle is the only indication of two sclerites.

Wings

Wing venation in several of the groups is valuable. It is often irregular and in certain groups the second cross nervure is present. In a number of forms the venation is indistinct, being obscured by colorations, which usually are valuable in separating the species.

Abdomen

In the female the sternum of segment seven, usually known as the last ventral segment, is one of the most important taxonomic structures. The posterior margin may be variously modified in different species so that it may contain deep notches, tooth like structures or concave emarginations, or appear lobed. It is often thickly chitinized and frequently bears conspicuous color markings.

In several species another structure occurs in connection with the sternum of segment seven which is referred to by other authors as the underlying membrane. It occurs in *comma, colon, sexvittatus, curtisii, texanus, dentatus,* and *lassus.*

The ninth segment of the female is the largest of the whole abdomen and is apparently composed of one plate, the tergum, which curves dorsally around the body, extending ventrally to the sides of the ovipositor. In taxonomic work they are generally referred to as the pygofers and may be strongly inflated laterally and beset with spines, especially in the ventral and apical regions. The ovipositor usually exceeds the pygofers in length.

In the male the sternum of segment seven is not variously modified as in the female. The sternum of segment eight is also unmodified, and is usually spoken of as the last ventral segment, the posterior margin appearing evenly concavely rounded or truncate and not differing from the previous sterna. The tergum of segment nine forms what is termed the pygofers and is often pubescent, especially in the apical region. The sternum of segment nine is usually a triangular plate, attached to the tergum by only a narrow margin and is termed the valve. A pair of structures appear to rise from and apparently are fused with the valve. They are often broad and variously produced and the apices may be rounded, pointed or truncate. These structures are termed the plates.

The Internal Genitalia

The internal structures are found in the genital chamber which is formed by the ventral genital plates and pygofers. These structures are composed of three parts, the styles, the oedagus, and the structures connecting these two, the style-oedagus connectives. These structures are probably modified appendages and arise from the ninth segment.

The styles are always paired and lie upon and are attached to the dorsal parts of the plates. They vary in shape, more specific variations are usually to be found in the terminal portions. The greater portion of the styles lie in the genital chamber, but the anterior portion often extends cephalad into the abdominal cavity. It is thought that the styles are used as claspers. A chitinous plate at the base which often appears as a pair of plates slightly joined, connects the two styles and also the styles to the oedagus. Hence, these structures are known as the style-oedagus connectives.

The oedagus is a chitinous structure posterior to and joined at its anterior end to the connectives. It appears to function as the penis sheath. The basal or anterior end is often enlarged and prolonged dorsally, usually attached to the genital membrane. The terminal portion also varies in shape and may be provided with hooks, barbs or spines. In the different species various shapes are noticed, which are, however, quite constant within the species.

Coloration

Although the coloration varies greatly in intensity the color pattern is quite definite in a number of species. These markings usually appear on the vertex or on the elytra in the form of transverse bars, rounded spots or longitudinal stripes. They are most important in the *Stirellus, Commellus, Remadosus, Drylix,* and *Ophiola* groups.

SYSTEMATIC

Key to the Genera of the *Euscelis* group

1.	Vertex parallel margined or slightly produced, much wider than long......	2
	Vertex definitely produced, flat or conical	5
2.	Vertex parallel margined, short and very broad	3
	Vertex with anterior margin slightly produced	4
3.	Vertex four times as broad as long, species very large	*Remadosus* Bell
	Vertex three times as broad as long, species small, elongate and wedge-shaped	*Drylix* Edwd.
4.	Vertex strongly convex between eyes, bluntly rounding to strongly inflated front, elytra light, nervures paler, ovipositor normal	*Athysanus* Burm.
	Vertex not strongly convex, front not inflated, elytra sub-hyaline, nervures dark, ovipositor extremely long	*Exitianus* Ball
5.	Vertex broad, distinctly wider between eyes than length on middle......	6
	Vertex narrow, basal width less than length on middle	*Stirellus* O. & B.
6.	Vertex and front obtusely or acutely conically produced	7
	Vertex and front angled, flat	*Commellus* O. & B.

7. Form broad and robust, species straw colored	8
Form not unusually broad, species small	9
8. Vertex bluntly conical, convex transversely and sloping to front	*Euscelis* Brul.
Vertex flattened at base, very thickly bluntly angled with front	*Amplicephalus* De L.
9. Vertex and front acute conically produced, markings in form of transverse bands	*Ophiola* Edwd.
Vertex produced, very slightly wider between eyes than length on middle, right angled	**Amblysellus** n. g.

Genus *Remadosus* Ball

Plates I, VI, and X

Remadosus Ball, Trans. Ent. Soc. Amer., LV, p. 3, 1929.

Vertex extremely short and broad, parallel margined, transverse, broadly rounding to front. Ocelli situated in a slight depression, distant from the eyes, distinctly below the level of the disc. Species very large. Venation simple.

Type of genus *Athysanus magnus* Osborn and Ball.

The species of this genus are very large with transverse heads and of a fuscous or black coloration.

Key[1] to Species of *Remadosus*

Definite ivory white costal stripe and usually an ivory white band on pronotum	*magnus*
Costal margin of elytra of same shade as disc, ivory band on pronotum faint or absent	*fumidus*

Remadosus magnus Osborn and Ball (Plates I, VI, and X)

Athysanus magnus Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 225, 1897.

Euscelis (*Athysanus*) *magnus* var. *piceous* Osb., Fla. Ent., VI, p. 19, 1922.

A large, rusty straw colored species distinguished by a definite ivory white costal band. Length 7 mm.

Vertex short, broad, almost parallel margined, four times as broad as long. Elytra distinctly longer than abdomen.

[1] Adopted from Ball

Color: variable, rusty straw to quite dark, vertex, pronotum and scutellum finely irrorate with fuscous, transverse ivory band on pronotum. Elytra dark, nervures pale fuscous, margined with light. Front dirty straw. Venter light.

Genitalia: Female last ventral segment as long as preceding, posterior margin roundingly produced, triangularly notched at middle, forming two rounding lobes, lateral angles produced, roundingly lobe-like. Male valve short, obtusely angled, triangular; plates four times as long as valve, tapering gradually to acute antennuated apices.

Species variable in intensity of color, darker form usually with a more prominent pronotal stripe, internal genitalia identical.

Distributed in the plains and prairie regions from eastern Wyoming and Colorado to Iowa and Minnesota, southward to Nebraska and Kansas and again along the Gulf coast in Louisiana, Mississippi, and Florida. Osborn and Ball report taking it from *Spartina michauxiana* in Iowa and Colorado. Nymphs and adults of both the light and dark forms have been taken in abundance on *Spartina patens* in a low meadow just above the tide flats at Tampa, Florida (Ball).

Type locality Ames, Iowa. Type in Agricultural College Collection, Ames, Iowa. Type examined, also specimens from Florida, Mississippi, and Iowa.

Remadosus fumidus Osborn (Plates I, VI, and X)

Euscelis (*Athysanus*) *fumidus* Osborn, Fla. Ent., Vol. VI. No. 2, p. 19, 1922.

Euscelis (*Athysanus*) *drakei* Osborn, Fla. Ent., Vol. VI. No. 2, p. 19, 1922.

Resembling *magnus* in size and form but readily distinguished by the costal margin being same shade as disc, ivory band usually present on pronotum. Female segment distinct. Length 6.5 mm.

Vertex short, almost parallel margined, four times as wide as long. Pronotum twice as broad as long, transverse.

Color: Variable, reddish to dark fuscous. Vertex finely irrorate with fuscous. Elytra dark, usually mottled with milky spots, nervures not distinct. Front, clypeus, and lorae dark fuscous with yellow irrorations.

Genitalia: Female last ventral segment slightly longer than preceding, posterior margin slightly roundingly produced and deeply narrowly incised at middle, lateral angles produced and broadly rounding. Male valve short, obtusely angled; plates triangular, four times longer than valve, apices acute.

A species variable in color, the dark *drakei* form showing no specific external structural differences and with internal genitalia identical with *fumidus.*

Described from a single male specimen collected at Chester, Georgia, and since collected from Florida in a low flat woods between cypress swamps from an association of *Rynchospora* sp. and *Spartina* sp. (Ball).

Type locality, Chester, Georgia. Type in Osborn collection. Type examined, also specimens from Sanford, Florida.

Genus Athysanus Burmeister[1]

Plates II, VI, and X

Athysanus Burmeister, Genera Ins., pl. 14, 1838.

Vertex short, slightly roundingly produced, disc convexly rounding to strongly inflated front, head with distinct swollen appearance. Venation of elytra simple. Apical cells slightly longer than broad. Ovipositor normal.

Type *argentatus* Fab.

Species much broader and shorter than *Exitianus,* not wedge-shaped, almost parallel margined.

Athysanus frigidus Ball (Plates II, VI, and X)

Athysanus frigidus Ball, Ent. News, X, p. 172, 1899.

A short robust species with a broad, rounding, inflated vertex and front, four black spots on anterior margin of vertex. Length 4–4.5 mm.

Vertex broadly rounding to tumid front, two and one half times as wide between the eyes as long, one half longer on middle than against eyes. Elytra slightly longer or equaling abdomen in length.

Color: Vertex whitish yellow, shining, four black spots on anterior margin, usually a small pair of spots on disc. Pronotum with four irregular black spots on anterior margin. Elytra pale, occasionally with fuscous bands, nervures

[1] According to Olsen *Eutettix osborni* Ball equals *Athysanus stactogalus* of Europe. However, this species is the type of the genus *Opsius* Fieb. and should be known as *Opsius stactogalus* Am.

paler. Face straw color with a pair of dark spots below median pair on vertex. Sutures dark. Venter pale.

Genitalia: Female last ventral segment twice as long as preceding, lateral angles produced, posterior margin slightly roundingly produced on median third. Male valve broadly obtusely rounding; plates triangular, twice longer than valve, outer margin slightly concavely emarginate, apices bluntly acute.

Present records indicate its distribution in Colorado, Western Utah, Nevada, California, North Dakota and Idaho. Dr. Ball reports taking it in abundance feeding on *Artemisia frigida.*

Type locality Ft. Collins, Colorado. Type in Ball collection. Type examined, also specimens from states previously mentioned.

Athysanus almus Van Duzee (Plate II)

Euscelis almus Van Duzee, Proc. Calif. Acad. Sci., XIV, No. 17, p. 421, 1925.

The following is the original description: Allied to *frigidus* Ball, a little narrower, with more pointed head; vertex with three round black spots, one of which is discal; elytra faintly fuliginous with pale nervures and fuscous marks in apical areoles. Length 4 mm.

Head a little wider than pronotum, vertex nearly horizontal at base, broadly rounded to base of front, polished. Front moderately broad, one-half longer than broad, nearly flat; sides slightly narrowed to apex; clypeus oblong, apex rounded, sides feebly excavated; lorae narrow. Pronotum a little longer than vertex, outer angles broadly rounded. Elytra with one or two supernumerary cross veins near apex of costa. Last ventral segment of female rather deeply, angularly excavated. Valve of male longer than ultimate segment, roundingly triangular. Plates long, obtuse at apex, sides feebly arcuated, contracted at base.

Color: Pale yellowish, deeper on head; vertex with three round black spots, median paler, placed forward of the lateral and minutely notched before; lateral placed near the eyes and just above the line of the ocelli; face with a row of four large black spots below margin, the lateral on the temples above the antennae; sutures of the face and about six arcs fuscous; pronotum scarcely darkened across the disc on anterior margin; scutellum usually with black spots near basal angles and two brown discal dots, apical field sometimes with two brown spots. Elytra pale smoky with conspicuous pale nervures. Apical transverse veins marked with brown and a brown vitta borders the apical veins; pleural pieces and abdomen more or less black, the last ventral segment of female with a black spot at fundus of notch; suture and dorsum of male pygofers black; legs pale, claws black.

No specimen of this species was available for study. Dr. Ball has recently placed it in the genus *Athysanus*.

Type locality Los Banos, Merced Co., Calif. Type in Mus. Calif. Acad. Sci.

Genus *Exitianus* Ball

Plates IV, VI, and X

Exitianus Ball, Trans. Ent. Soc. Amer., LV, p. 5, 1929.

Vertex bluntly angled, convex between eye, anterior margin rounding to front, the front not inflated. Venation of elytra simple, apical cells much longer than broad, appendix broad. Ovipositor extremely long, acutely produced, greatly exceeding the slender pygofers.

Type of genus *obscurinervis* Stål.

Species usually with dark spots on vertex and smoky hyaline elytra.

Exitianus obscurinervis Stål (Plates IV, VI, and X)

Jassus (*Thamnotettix*) *obscurinervis* Stål, Eug. Resa. Ins. Hemip. p. 293, 1858. (S. A.)

Cicadula exitiosa Uhl., Am. Ent. III, p. 72, 1880. (U. S.)

Athysanus picatus Gib., Proc. Bic. Soc. Wash. 32 p. 26, 1919 (C. A.)

Athysanus miniaturatus Gib., Proc. Bic. Soc. Wash. 32 p. 26, 1919. (C. A.)

Euscelis obscurinervis Osborn, Annals Carnegie Museum, Vol. XV, p. 412.

A variable species in size and intensity of coloration, with blunt head, hyaline elytra and distinct genitalia.

Vertex obtusely angular, slightly over one-half as long as basal width, anterior margin broadly and thickly rounding to wedge-shaped front. Elytra exceeding abdomen in length, appendix broad, apical cells long and narrow.

Color: Vertex pale grayish white, often tinged with orange yellow, ocelli red, pair of large round black spots on margin, often a smaller one between, two oblique dashes on basal angles, a brownish transverse crescent between the often enlarged anterior extremities and parallel to the anterior margin. Pronotum with a row of irregular black spots. Scutellum with a pair of triangular spots on basal angles and an irregular line either side of middle. Elytra hyaline, nervures dark fuscous. Face pale yellow with dark arcs, sutures dark. Venter pale.

Genitalia: Female last ventral segment twice longer than preceding, truncate, posterior margin slightly convexly produced on middle; ovipositor greatly exceeding pygofers. Male plates long, narrow, two and one-half times length of valve, tapering gradually, outer margins weakly concave, tips acute, often divergent and clothed with stout hairs.

Species very widely distributed, common throughout the United States, having only recently spread over the north. It is probably a native of South or Central America and has migrated to the West Indies, United States and northward. It occurs very abundantly on the grasses, often overrunning wheat and fall rye, where it frequently accumulates in great numbers and does considerable damage. Apparently there are two broods a season in the North (Osborn and Ball).

Type localities Buenos Ayres and Rio Janeiro. Type probably in Stockholm Museum. Numerous specimens examined from many localities in United States, Mexico, Cuba, and Brazil.

Genus *Drylix* Edwards

Plates I, VII, and IX

Drylix Edwards, Ent. Mo. Mag., LVIII, p. 207, 1922.

Vertex short, not extremely broad, slightly produced, almost parallel margined, rounding to front. Ocelli distinctly below the level of the vertex. Venation of elytra simple, apical cells elongated.

Type of genus *striola* Fallén.

The species of this group usually have a black band on vertex and the female segment is excavated.

Key to Species of *Drylix*

1. Vertex definitely produced, not transverse, male plates triangular .... *striolus* Fall
   Vertex not definitely produced, almost parallel margined, male plates not triangular 2
2. Male plates convexly rounding, semicircular .... *parallelus* V. D.

	Male plates not semi-circular	3
3.	Male plates with truncate apices	**truncatus** n. sp.
	Male plates produced caliper like	4
4.	Plates long, caliper like, apices narrowly produced	*divaricatus* S. & Del.
	Plates short, caliper like, apices thickly bluntly produced	*uneolus* Ball

Drylix striolus Fallén (Plates I, VII, and IX)

Cicada striola Fallén, Acta Holm, XXVII p. 31, 1806.

A small wedge-shaped species, greenish yellow in color. Genitalia distinct. Length 4–5 mm.

Vertex a little less than one-half as long on middle as wide between the eyes, slightly longer than half the length of the pronotum.

Color: Vertex greenish yellow with a transverse black band just back of ocelli. Pronotum and scutellum greenish yellow, usually without markings. Elytra pale greenish hyaline, nervures pale. Face dark with arcs of yellow; legs and venter yellowish. Ovipositor black.

Genitalia: Female last ventral segment one-half longer than preceding, lateral margins obliquely sloping, posterior margin strongly concavely hollowed, ovipositor exceeding pygofers. Male valve obtusely triangular; plates four times longer than valve, convexly rounding to blunt apices.

This species is widely distributed throughout the Northeastern United States, extending as far westward as the Dakotas and Colorado and southward to New Jersey and northward into Ontario. Common in swampy regions where small sedges abound. Dr. De Long reports it on *Juncus, Cyperus diandrus,* and *Carex-Phragmites* association at Presque Isle, Pennsylvania.

Type probably in Stockholm Museum. Numerous specimens examined from a great variety of localities.

Drylix parallelus Van Duzee (Plates I, VII, and IX)

Athysanus parallelus Van Duzee, Can. Ent., XXIII, p. 169, 1891.

A pale yellowish green species resembling *striolus* but larger, with a shorter head and distinct genitalia. Length 6 mm.

Vertex distinctly parallel margined, not longer on middle than against eyes. Elytra distinctly longer than abdomen.

Color: Vertex pale yellowish green, a broad shining black band just back of ocelli. Elytra pale greenish subhyaline, nervures with yellowish tint. Face yellow with several dark arcs. Venter light yellow. Ovipositor black.

Genitalia: Female last ventral segment twice longer than preceding, truncate behind, lateral angles rounding, a deep triangular median notch extending to near middle of segment. Male valve broad as the ultimate segment; plates narrower, twice as long as valve, convexly rounding to blunt divergent apices.

Widely distributed in Northeastern United States extending from Ontario southward to New Jersey and westward to Colorado, where it occurs in swampy and marshy places. Dr. De Long reports it common on *Juncus* and small sedges along lagoon margins at Presque Isle, Pennsylvania.

Type locality South Falls, Ontario. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection. Specimens examined from numerous localities.

Drylix **truncatus** n. sp. (Plates I, VII, and IX)

Similar in size and structure to *parallelus,* but of darker color and with distinct genital characters. Length 5 mm.

Vertex broad, almost parallel margined, three times as broad as long. Pronotum twice as long as vertex. Elytra long, greatly exceeding abdomen.

Color: Vertex greenish yellow, a broad black band just back of ocelli, anterior margin of pronotum narrowly black, a broad transverse band on posterior half. Disc of scutellum black, a pair of black spots in basal angles. Elytra dark, nervures pale. Face dark with about seven arcs of yellow. Venter dark.

Genitalia: Male valve broad, bluntly angled; plates short, only slightly exceeding valve, almost as broad at apices as at base, truncate.

Described from two male specimens, one collected at Prentice, Ohio, and one at Lakeside, Ohio, on July 17, 1916.

Type in De Long collection.

Drylix divaricatus Sanders and De Long (Plates I, VII, and IX)

Euscelis divaricatus Sanders and De Long, Pro. Ent. Soc. Wash., Vol. 25, No. 7–8, 1923.

Very similar in general appearance to *parallelus* but with distinct genital characters. Length 5.5 mm.

Vertex almost parallel margined, three times as broad as long. Pronotum twice longer than vertex. Elytra long, greatly exceeding abdomen in male. Length 5.5 mm.

Color: Greenish yellow, vertex with black transverse band just back of ocelli, a small spot on apex. Pronotum and scutellum without markings. Elytra smoky. Front with remnants of about eight pairs of arcs, heavy undulating line below ocelli, dark. Venter dark.

Genitalia: Female last ventral segment one-half longer than preceding, posterior margin almost truncate, only slightly excavated on median third, black margined. Male valve broad, triangular; plates slightly longer than broad at base, outer margin convexly rounding, inner margins approximate one-half their length, then abruptly concavely rounded to widely divergent, acutely produced tips.

Described from a single specimen collected at Presque Isle, Pennsylvania, where it occurred with *parallelus* in a sedge habitat. It has been reported from Idaho (Haegele).

Type locality Presque Isle, Pennsylvania. Type in De Long collection. Type examined, also specimens from Idaho.

Drylix uneolus Ball (Plates I, VII, and IX)

Drylix uneolus Ball, Trans. Am. Ent. Soc., Vol. LV, p. 6, 1929.

Resembling *divaricatus* in general appearance but with genital characters distinct. Length 5.5 mm.

Vertex almost parallel margined, slightly produced, three times as broad as long. Pronotum twice as long as vertex. Elytra not greatly longer than abdomen.

Color: Vertex greenish yellow, broad transverse black band just back of ocelli, arcuate line on apex and two transverse sinuate lines along posterior margin next either eye. Elytra brownish, nervures pale. Ovipositor black.

Genitalia: Female last ventral segment longer than preceding, lateral margins long, acutely produced, posterior margin deeply concavely excavated on median third, semicircular, heavily margined with black. Male valve broad, obtusely angular; plates as broad at base as long, outer margins convexly rounding, inner margins approximate less than one-half their length, then rounded to thick, stubby, caliper like apices.

This species was taken by sweeping a wet meadow (Ball). Known only from Utah and North Dakota.

Type locality, Peterboro, Utah. Type in Ball collection.

Specimens examined from Devil's Lake, North Dakota and Mantua, Utah.

Genus *Euscelis* Brullé[1]

Plates II, VII, and IX

Euscelis Brullé, Expéd. Sci. Morée, III, p. 109, 1832.

Vertex bluntly conically produced, disc convex between the eyes, slightly more convex at apex than at base, rounding thickly to front. Form broad and stout. Elytra usually shorter than abdomen, second cross-nervure often present, apical cells short and broad.

Type of genus *lineolatus* Brullé.

Species belonging to this group generally straw colored. Female segment always concavely excavated and usually bearing a small black triangular tooth at apex.

Key to Species of *Euscelis*

1.	Male plates with apices divergent	2
	Male plates with apices antennuated	3
2.	Species small, 4 mm. or less	*ovatus* S. & DeL.
	Species large 5 mm. or over	*extrusus* V. D.
3.	Male plates rounding regularly to blunt apices	4
	Male plates with truncate apices	5
4.	Vertex short, broadly rounding, scarcely produced, less than one-third longer on middle than against eye	*deceptus* S. & DeL.
	Vertex produced, obtusely angled, over twice longer on middle than against eye	*alpinus* Ball
5.	Vertex short, broadly rounding, less than one-half longer on middle than against eye. Female segment bearing median tooth	*relativus* G. & B.
	Vertex strongly produced, twice longer on middle than against eye. Female segment not bearing median tooth	*hyperboreus* V. D.

Euscelis extrusus Van Duzee (Plates II, VII, and IX)

Athysanus extrusus Van Duzee, Can. Ent. XXV, p. 283, 1893.

A broad stout species, variable in color, resembling *obsoletus* but with a longer vertex and distinct genitalia.

[1] This name will supersede *Metathysanus* Dahl and *Conosanus* O. & B. as the oldest generic name for this group.

Length, brachypterous form 5–5.5 mm., macropterous form 6 mm.

Vertex obtusely angled, almost three-fourths as long as width between eyes. Elytra broad, rounded behind, in brachypterous form exposing the pygofers in female and plates in male. Apical cells short and broad. Second cross-nervure often present.

Color: Vertex light straw, an oblique pair of spots at apex, a transverse spindle shaped marking between eyes, dark fuscous. Pronotum and scutellum dirty straw with irregular markings. Elytra light straw, nervures paler, areoles margined with fuscous. Front pale with arcs of fuscous, sutures dark. Venter pale. In pale specimens markings may be faint or entirely absent.

Genitalia: Female last ventral segment twice the length of the preceding, lateral margins rounded and sloping inwardly to acutely pointed lobe, between these rather deeply excavated. Male valve obtusely triangular; plates roundingly cut out from inside to the parallel outer margins, three times the length of the valve, style like tips of the pygofers extending beyond the plates.

Species common to northeastern United States and Ontario. It has been taken from fresh water marshes (De Long) and low ground meadows and pastures (Osborn and Ball). No detailed data is available on its life history. Osborn and Ball report one generation a year in Iowa, overwintering in the nymphal state.

Type localities Portage Falls, New York, and Northford, Connecticut. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection. Numerous specimens examined from a great many localities.

Euscelis ovatus Sanders and De Long (Plates II, VII, and IX)

Euscelis ovatus Sanders and De Long, Bull. Bur. Plant Industry, Penna., Vol. III, No. 15, p. 161, 1920.

Resembling *extrusus* in general appearance but readily distinguished by the smaller size, distinct style like processes of the pygofers and distinct genitalia. Length 4 mm.

Vertex obtusely angled, slightly longer on middle than half the width between the eyes. Pronotum twice as broad as long, one-third longer than vertex. Elytra broad and distinctly shorter than abdomen in both sexes.

Color: Vertex pale straw, a pair of median transverse spots, rounding on median side and tapering to a line just back of ocelli, dark brown. Pronotum pale yellow, often irregularly marked with fuscous. Scutellum usually with an irregular pair of spots on anterior margin. Elytra pale, nervures light, often narrowly margined with fuscous. Face pale straw with about eight arcs of fuscous, sutures dark. Vertex dirty straw with occasional dark markings.

Genitalia: Female last ventral segment longer than preceding, lateral margins sloping inwardly to pointed lobes, posterior margin between these abruptly shallowly excavated either side the slightly roundingly produced middle. Male valve obtusely rounding; plates triangular, distinctly broader than long, convexly rounding on inner and outer margins to blunt apices, diverging immediately at apex of valve, exposing the oedagus and curved style like process of the pygofers.

Described from specimens collected from wheat at Wellington, Kansas, and since collected in Texas (Tucker).

Type locality Wellington, Kansas. Type in Sanders and De Long collection. Type examined, also specimens from Texas.

Euscelis alpinus Ball (Plates II, VII, and IX)

Athysanus alpinus Ball, Ent. News, X, p. 173, 1899.

Size and form of *deceptus* but with different color pattern and more pointed vertex. Genitalia distinct. Length 4.5 to 5 mm.

Vertex distinctly angled, two-thirds as long as broad, slightly more than twice as long on middle as against eyes. Elytra shorter than abdomen in female, slightly longer in male.

Color: Vertex pale straw colored, two transverse fuscous bands, the anterior one narrow, arising just back of ocelli against eyes, angling forward, nearly parallel with vertex margin, paralleled posteriorly by a broader, more irregular one. Pronotum and scutellum pale, pronotum with four irregular longitudinal stripes not reaching anterior margin, median pair produced onto scutellum, confluent. Elytra pale, nervures paler, occasionally margined with fuscous blotches. Face bright yellow, with arcs of dark fuscous. Venter pale.

Genitalia: Female segment longer than preceding, lateral angles rounding, posterior margin slightly concavely excavated, a stout median process armed with two divergent teeth. Male valve broad as ultimate segment, rounding; plates triangular, three times length of valve.

Described from numerous specimens taken from a damp mountain meadow in Colorado and since reported from New Hampshire (Slosson). Nothing is known regarding its food plant.

Type locality Little Beaver, Colorado. Type in Ball collection. Type examined.

Euscelis obsoletus Kirschbaum[1] (Plates II, VII, and IX)

Athysanus obsoletus Kirschbaum, Die Athysanus arten V. Wiest., p. 7, 1885.

A straw colored species resembling *deceptus* in general appearance but distinguished by the more angled vertex. Length 5–5.5 mm.

Vertex broader and distinctly more angled than in *deceptus*, longer on middle than half the width between the eyes. Elytra usually exceeding the abdomen.

Color: Vertex, pronotum, and scutellum dirty yellow, vertex with a pair of irregular black spots between eyes on disc, a pair of oblique dashes above and a pair of small spots against either eye, dark brown. Elytra testaceous. Venter dark.

Genitalia: Female last ventral segment twice longer than preceding, lateral angles rounding, posterior margin shallowly excavated, slightly narrowly produced at apex. Male valve triangular; plates convexly rounding to blunt apices, two and one-half times longer than valve.

This species apparently does not occur in this country. No American forms were found to agree with European examples from Dr. China and Dr. Melichar. The internal genital characters are distinct from all forms examined.

Numerous specimens were examined from Germany, Ireland, England and Scotland.

Euscelis deceptus Sanders and De Long (Plates II, VII, and IX)

Euscelis deceptus Sanders and De Long, Ann. Ent. Soc. Am., X, p. 87, 1917.

In size and form resembling *obsoletus*, but distinguished by a much shorter, more rounding vertex. Length 5.5 to 6 mm.

Vertex short, broadly rounding, less than one-half as long as wide, scarcely one-third longer on middle than against eye. Elytra broad, exceeding abdomen.

[1] Apparently this species, from the determinations at hand, does not occur in North America.

Color: Ocelli blood red. Vertex, pronotum, and scutellum straw colored, vertex with irregular transverse brown markings, pronotum with a row of indistinct spots, a pair of irregular spots on disc of scutellum. Elytra dirty with intermediate brown markings, nervures indistinct. Front pale as also the venter.

Genitalia: Female last ventral segment twice longer than preceding, lateral angles rounding to the broadly excavated posterior margin, bearing at its apex a small median tooth, black. Male valve short, triangular; plates broad, three times longer than valve, convexly rounding to blunt apices.

Species common to North America. Very common in the New England states, Ohio, Illinois, Wisconsin, and South Dakota. Specimens of *Athysanus sahlbergi* Reut. from Dr. China appear to agree with *deceptus* and further study may show them to be the same.

Type locality Wisconsin. Type in De Long collection.

Type examined, also specimens from states previously mentioned.

Euscelis relativus Gillette and Baker (Plates II, VII, and IX)

Athysanus relativus Gillette and Baker, Hemip. Colo., p. 93, 1895.

A short stout straw colored species resembling *deceptus* but smaller and with distinct genitalia. Length 4 mm.

Vertex obtusely angled, slightly over one-half as long as width at base. Elytra short, rarely reaching to the end of the abdomen, rounding behind.

Color: Ocelli reddish, vertex straw colored, often with a few irregular pale fuscous markings. Elytra pale yellowish subhyaline, nervures not distinct. Face pale with dark arc, sutures dark. Venter pale yellow.

Genitalia: Female last ventral segment longer than preceding, lateral angles rounding to posterior margin, which is rather deeply roundingly excavated, bearing at its apex a short, black, acutely pointed tooth. Male valve short, obtusely triangular; plates two and one-half times as long as valve, convexly rounding to broad, truncate apices. Margins sparsely fringed with hairs.

At the time of this study the type of this species was unavailable and Professor Sanders' identification has been used. This form appears as *obsoletus* in Professor Osborn's collection.

Specimens were examined from Ireland and Scotland and found to agree with American forms. Distinctly northern in distribution, common in New England and Vancouver Island. It has also been reported from Illinois, Iowa, and Wisconsin. No definite host plant has been designated but it probably feeds on grasses. Professor Osborn reports sweeping it from timothy.

Type locality Fort Collins, Colorado. Type probably in Baker collection, United States National Museum. Specimens examined from Maine and Wisconsin.

Euscelis hyperboreus Van Duzee (Plates II, VII, and IX)

Euscelis hyperboreus Van Duzee, Rept. Can. Arc. Exped., Vol. III, 1919.

Resembling *extrusus* in form and general coloration, but smaller and with distinct genitalia.

Vertex strongly produced, distinctly angulate, longer on the middle than width between eyes. Elytra short, only slightly exceeding abdomen in the male, much shorter in the female.

Color: Yellowish testaceous. Vertex with arcuated line on anterior margin, reaching from apex to ocelli, a transverse line between ocelli. Pronotum with about 10 faint marks on anterior margin. Scutellum with a pair of dashes on disc. Elytra yellowish, nervures pale, margined with broken fuscous. Front yellowish with about 8 pair of fuscous arcs. Legs pale. Venter dark.

Genitalia: Female last ventral segment as long as preceding, posterior margin deeply concavely hollowed, very slightly and narrowly produced at apex. Male valve triangular; plates about as broad at truncate apices as at base.

Type localities Kongenevik, Camden Bay, Alaska, and Bernard Harbor, Northwest Territories. Type in the National collection of Insects, Ottawa.

Specimens examined from Nome, Alaska.

Genus *Ophiola* Edwards

Plates III, VIII, and IX

Ophiola Edwards, Ent. Mo. Mag., p. 206, 1922.

Vertex produced in front of eyes, acutely conical, disc not strongly convex between eyes, sloping regularly from pronotum to apex. Form small, narrow, and elongate.

Type of genus *striatulus* Fallén.

The species placed in this genus can usually be recognized by the black coloration on the vertex in the form of transverse bars.

Key to Species of *Ophiola*

1.	Elytra but little exceeding the body, apical cells broad and relatively short	2
	Elytra definitely longer than body, apical cell long and narrow	6
2.	Species large, 4 mm. and over	3
	Species small, 3.5 mm. and less	5
3.	Vertex broadly rounding, scarcely longer on middle than at eye. Species shining black, elytra truncate	*anthracina* V. D.
	Vertex definitely pointed	4
4.	Vertex obtusely angled, one-half longer on middle than at eye, elytra truncate behind, species dark	*uhleri* Ball
	Vertex acutely angled, species straw colored	*shasta* Ball
5.	Female segment twice longer than preceding; vertex always sulphur yellow, unmarked	*humida* Osb.
	Female segment slightly longer than preceding lateral angles acutely produced, vertex tawny with definite fuscous markings	*arctostaphyli* Ball
6.	Elytra extremely long and narrow	7
	Elytra moderately long	9
7.	Vertex distinctly obtusely angled, twice longer on middle than at eye, elytra dark	*cornicula* Marsh.
	Vertex broadly rounding, species dark	8
8.	Vertex one-half longer on middle than at eye, irregular transverse markings. Female segment truncate, not forming median tooth	*angustata* Osb.
	Vertex scarcely longer on middle than at eye, single transverse band. Female forming dark median obtuse point	*cuneata* S. & DeL.
9.	Vertex broadly rounding, species large, 4.5 mm. and over	10
	Vertex definitely obtusely angled	13
10.	Species straw colored, vertex with irregular black spots and transverse bands	11

	Species dark with definite transverse bands on vertex	12
11.	Vertex and front strongly inflated, twice longer on middle than at eye	*calvata* Ball
	Vertex not inflated, less than one-half longer on middle than at eye	*gentilis* V. D
12.	Vertex strongly sloping, one-half longer on middle than at eye, transverse bands interrupted, fuscous, cross-nervures broadly white	*vara* Ball
	Vertex not strongly sloping, twice longer on middle than at eye, transverse bands continuous	*symphoricarpae* Ball
13.	Vertex acutely conical, almost right angled, tawny, with definite fuscous markings	*comptoniana* Ball
	Vertex obtusely angled	14
14.	Ground color olivaceous or orange with wavy transverse lines on vertex, always confluent at one or more points	15
	Ground color yellow with transverse lines, not wavy, never confluent; elytra yellowish subhyaline	**luteola** n. sp.
15.	Species with definite olive cast, fore and middle femora twice banded with white	*striatula* Fall.
	Species with definite orange cast, fore and middle femora shining black to just before the apex, then abruptly orange as are the tibia	*osborni* Ball

Ophiola uhleri Ball (Plates III, VIII, and IX)

Athysanus (*Conosanus*) *uhleri* Ball, Can. Ent. 43, p. 200, 1911.

Athysanus (*Conosanus*) *plutonius* Osborn and Ball, Rev. Athy., p. 200, 1902.

A broad robust species with bluntly angled vertex, elytra truncate behind. Length 4 mm.

Vertex distinctly angulate, almost twice as long on middle as against eye, one-half as long as broad and three-fourths the length of pronotum. Elytra short and broad, truncate posteriorly, slightly exceeding the abdomen.

Color: Black to yellowish brown, line on posterior margin of vertex, oblique spot against either eye and a pair medianly near the apex, yellow. Pronotum and scutellum with a few irregular spots. Elytra usually dark, occasionally nervures are creamy.

Genitalia: Female last ventral segment slightly longer than preceding, posterior margin roundingly produced, lateral angles bluntly rounded. Male valve bluntly convexly rounding; plates triangular, two and one-half times length of valve, apices blunt, margins thickly clothed with yellow hairs. Internal genitalia distinct and illustrated.

Species dark in color, vertex with varying amount of orange.

A common species in Northwestern United States, extending westward to Colorado and South Dakota, south to Washington, D. C., and northward into Canada. It has been swept from low ground meadows (Osborn).

Type locality Ames, Iowa. Type in Ball collection. Species examined from numerous localities.

Ophiola uhleri var. *speculata* Ball, Bull. Brooklyn Ent. Soc., Vol. XXIII, No. 4, p. 187, 1928.

Resembling *uhleri* in size and form, but of a yellowish brown coloration. Slight markings sometimes present on the vertex. Genitalia identical with *uhleri,* both externally and internally.

Dr. De Long reports sweeping it from a sweet fern association. Type locality Speculator, N. Y. Type in Ball collection.

Ophiola anthracina Van Duzee (Plates III, VIII, and IX)

Athysanus anthracinus Van Duzee, Can. Ent., XXVI, p. 1894.

Resembling *uhleri* in size and form, but darker and distinguished by the shorter, more broadly rounding vertex. Length 4 mm.

Vertex broadly obtusely conical, slightly longer on middle than against eye, two-thirds as long as broad. Pronotum twice longer than vertex. Elytra broad and short, truncate behind, slightly exceeding abdomen.

Color: Shining black, two spots on posterior margin of vertex farther removed from one another than from the eyes. Elytra black, nervures always dark. Front and venter dark.

Genitalia: Female last ventral segment longer than preceding, lateral angles sub-acute, posterior margin slightly roundingly produced. Male valve convexly rounding; plates triangular, two and one-half times as long as valve, apices blunt, lateral margins sparsely clothed with dark hairs.

This species can be readily distinguished from *uhleri* by the short blunt vertex.

Occurs commonly in Northeastern United States, extending as far west as Colorado. It has been reported feeding abundantly on high dry meadows and hillsides in Ohio and Maine by Professor Osborn.

Type localities Iowa, Kansas, and Colorado. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection. A large number of specimens examined from numerous localities in Eastern United States.

Ophiola arctostaphyli Ball (Plates III, VIII, and IX)

Athysanus arctostaphyli Ball, Ent. News, X, p. 172, 1899.

Similar to *striatula* in general appearance, but broader and shorter. Length 3.5 mm.

Vertex bluntly angled, slightly over one-half longer on middle than width between eyes. Pronotum little more than one-fourth longer than vertex. Elytra not exceeding abdomen in length.

Color: Vertex tawny yellow with definite fuscous markings. Transverse line between reddish ocelli, near middle suddenly directed obliquely forward to near apex, posteriorly two irregular transverse lines confluent by a median longitudinal line in middle, again next the eyes. Posterior line broken forward on each side at a point nearer the eyes than the middle, pronotum irregularly marked with fuscous. Scutellum with a pair of fuscous markings in basal angles, pair of bilobed spots on disc. Elytra testaceous, subhyaline, nervures pale, heavily bordered with fuscous. Front tawny with distinct arcs of fuscous, venter brownish with dark.

Genitalia: Female last ventral segment slightly longer than preceding, posterior margin slightly produced, lateral angles acutely produced. Male valve bluntly, convexly rounding; plates triangular, two and one-half times as long as valve.

Occur in mountainous regions and has been collected in Colorado, Maine, New Hampshire and Connecticut. Both nymphs and adults were taken from bearberry in the mountains of Colorado

(Ball). No doubt common on high heath habitats in mountainous regions.

Type locality Rist Cañon, Colorado. Type in Ball collection. Type examined, also specimens from states mentioned previously.

Ophiola humida Osborn (Plates III, VIII, and IX)

Athysanus humidus Osborn, Me. Agr. Exp. Sta., Bull. 238, p. 131, 1915.

In general appearance resembling *arctostaphyli* but more slender and readily distinguished by the longer, more angled, sulphur yellow vertex. Length 3.5 mm.

Vertex obtusely angled, slightly more than twice longer on middle than against eyes. Pronotum one-third longer than vertex. Elytra exceeding abdomen.

Color: Vertex pale sulphur yellow, unmarked. Pronotum and scutellum yellow with faint fuscous markings. Elytra subhyaline, pale testaceous, nervures paler, faintly to darkly bordered with fuscous. Front faintly inscribed. Venter pale.

Genitalia: Female last ventral segment almost three times longer than preceding, lateral angles rounding, not produced, posterior margin almost truncate. Ovipositor distinctly longer than pygofers. Male valve obtusely rounding; plates triangular, three times length of valve, tapering gradually to blunt apices.

A rather uniform sulphur yellow species known only from Maine and Wisconsin. No host plant has been designated, although Professor Osborn reports never to have taken it outside of distinct bog situations.

Type locality Orono, Maine. Type in Osborn collection. Type examined, also specimens from Wisconsin.

Ophiola shasta Ball (Plates III, VIII, and IX)

Athysanus shastus Ball, Ent. News, XXVIII, p. 174, 1916.

Resembling *arctostaphyli,* but larger and with an acutely pointed vertex. Length 4.5–5 mm.

Vertex narrowly acutely produced at apex, two-thirds as long on middle as wide between the eyes, two-thirds as long as pronotum. Elytra distinctly longer than abdomen.

Color: Brownish straw, vertex with dark markings as in *arctostaphyli,* but inclined to fade out in places, the posterior line very faint. Elytra pale brownish hyaline, nervures pale, lightly margined with fuscous. Front light with a few arcs of dark, sutures dark. Venter light as are the legs.

Genitalia: Female last ventral segment slightly longer than preceding, truncate, lateral margins produced, subacute. Male valve obtusely rounding; plates triangular, two and one-half times as long as valves, apices blunt.

This species was described from specimens collected from Dunsmuir, California, and since collected at Castella and Colfax, California. Type in Ball collection. Specimens examined from Castella and Colfax, California.

Ophiola gentilis Van Duzee (Plates III, VIII, and IX)

Euscelis gentilis Van Duzee, Proc. Calif. Acad. Sci., Vol. XIV, No. 17, p. 420, 1925.

A large straw colored species with a round black spot just back of each ocellus.

Vertex broad and short, rounding, two and one-half times as wide as long, one-half longer on middle than at eye. Pronotum twice as long as vertex. Elytra definitely longer than body.

Color: Straw yellow, vertex with three reddish brown transverse bands, the median merging into a round black spot just back of each ocellus. Elytra straw color, nervures pale, lightly margined with brown. Front pale straw with fuscous arcs. Venter light.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles produced and prominent, acute, posterior margin slightly, broadly, roundingly produced.

The only records for this species are from California, Oregon, and Montana. Nothing is known regarding its food plant.

Type locality Hobergs Resort, Lake County, California. Type in the Museum of the California Academy of Science. Specimens examined from Le Grand, Oregon.

Ophiola finitima Van Duzee

Euscelis finitimus Van Duzee, Proc. Calif. Acad. Sci., Vol. XIV, No. 17, p. 422, 1925.

The following is the original description: "Head little wider than pronotum, obtusely angled; vertex nearly flat, about two-thirds wider than long; front broad, its length and width sub-equal, sides straight above, incurved to clypeus, abruptly raised above level of cheeks; clypeus oblong, a little narrowed to the rounded apex; pronotum long, twice as long as vertex, sides broadly rounded behind the eyes; elytra shaped much as in *Eutettix suboenea,* with arcuate costa and flaring tips, with four or five supernumerary veinlets in outer areole of clavus. Last ventral segment of female broadly excavated, the outer angles subacute, middle with a broad short lobate tooth which is feebly angled; pygofers short and broad. Valve of male short, broad, triangular and convex, a little shorter than the pygofers.

Color: Light fulvous brown, clearer beneath, polished; vertex with an angular black mark on each side between ocellus and eye, but showing a tendency to being drawn out into a transverse band; anterior to these spots are two curved darker lines either side the middle and another indicated near the hind margin. Pronotum irrorate with pale, with a large pale area behind the eyes; elytral nervures, except the marginal, pale; minute points at base of tibial spines and claws black.''

This species was not available for examination but from the description it undoubtedly belongs in the *Ophiola* group. Dr. Ball has recently placed this species as a color variety of *gentilis* but according to Van Duzee, ''they are absolutely distinct, especially in the male genital characters. The females are harder to distinguish but the vertex is much shorter in *gentilis* and there are other differences that make them recognizable.''

Ophiola calvata Ball (Plates III, VIII, and IX)

Athysanus calvatus Ball, Can. Ent., XXVII, p. 5, 1901.

A brownish yellow species with a broadly rounded and inflated vertex. Length 4.5 mm.

Vertex broadly rounding, strongly inflated, one-half as long on middle as wide between the eyes. Pronotum twice longer than vertex. Elytra distinctly longer than abdomen.

Color: Vertex brownish yellow, faint transverse lines anteriorly, a pair of dark spots against either eye, often elongated transversely. Pronotum and scutellum dirty straw washed with yellow. Elytra straw colored, sub-hyaline, nervures paler, lightly margined with fuscous. Front bright straw with patches of dark brown.

Genitalia: Female last ventral segment slightly longer than preceding, lateral margins bluntly produced, posterior margin slightly concavely excavated either side a produced median rounding lobe. Male valve broadly rounding, semicircular; plates triangular, two and one-half times as long as valve, apices bluntly acute, heavily clothed with hairs.

The strongly inflated, broadly rounding vertex gives this species a unique appearance and distinguishes it from all others in this group.

This species was described from specimens collected at Richfield and Logan, Utah, and since reported from Western Colorado (Ball) and Idaho (Haegele). Nothing is known regarding its food plant.

Type locality Richfield and Logan, Utah. Type in Ball collection. Specimens examined from type localities and Idaho.

Ophiola cornicula Marshall (Plates III, VIII, and IX)

Jassus corniculus Marshall, Ent. M. Mag., II and III, pp. 198–199, 1866.

Jassus orichalceus Thomson, Opusc. Ent. 1, pp. 56–72, 1869.

Jassus plutonius Uhler, Bull. U. S. Geol. Survey, III, p. 470, 1877.

Athysanus instabilis Van Duzee, Can. Ent., XXV, p. 284, 1893.

Athysanus elongatus Osborn, Maine Agr. Exp. Sta. Bull., 238, p. 129, 1915.

Resembling *arctostaphyli* in color and markings but much narrower and the elytra greatly exceeding the abdomen. Apical cells greatly elongated. Length 4.5 mm.

Vertex distinctly angled, much more than one-half longer on middle than width between eyes. Pronotum one and one-half times longer than vertex. Elytra greatly exceeding abdomen.

Color: Ocelli red, vertex pale dirty yellow with three dark transverse lines as in *arctostaphyli,* heavier, the posterior one broken forward touching the median near either eye. Pronotum and scutellum heavily marked with dark. Front dark with faint arcs of yellow. Elytra testaceous, sub-hyaline, nervures pale heavily margined with fuscous. Legs and venter dark.

Genitalia: Female last ventral segment one-half longer then preceding, lateral angles bluntly produced, posterior margin slightly roundingly produced. Male valve bluntly convexly rounding; plates triangular, two and one-half times longer than valve, tips blunt.

The writer has compared European examples of *Athysanus corniculus* from Dr. China with American examples of *Athysanus plutonius* Uhl. and can find no character by which they can be separated.

This species is common to the New England states and reported as far south as New Jersey. It is undoubtedly widely distributed over Northeastern United States, occurring in swampy and marshy areas where it perhaps feeds on some heath plant. Professor Osborn reported it on blueberry (Maine).

Numerous specimens were examined from England, New Jersey, Maine, Ontario, New York, and Connecticut.

Ophiola angustata Osborn (Plates III, VIII, and IX)

Athysanus angustatus Osborn, Me. Agr. Exp. Sta. Bull., 238, p. 130, 1915.

In general appearance resembling *cornicula*, but smaller and with a shorter, more rounding vertex. Genitalia distinct. Length 4 mm.

Vertex broadly rounding, less than one-half as long on middle as wide between the eyes. Pronotum twice longer than vertex. Elytra greatly exceeding abdomen.

Color: Vertex greenish yellow with more or less irregular fuscous markings. Elytra brownish to yellowish hyaline, nervures pale, faintly to distinctly bordered with fuscous. Front yellowish with several arcs of dark, clypeus and lorae yellow, sutures dark. Venter dark except lateral margins, which are yellow as are the pygofers.

Genitalia: Female last ventral segment equal to preceding, posterior margin almost truncate behind, lateral angles very blunt, not produced. Male valve short, broadly rounding, twice longer than last ventral segment; plates triangular, three times longer than valve, tips blunt.

This species was described from specimens taken in Maine and since collected from Cranberry Lake, New York (Osborn) and Lake Placid, N. Y. (Van Duzee). Practically nothing is known regarding its food plant, although it undoubtedly feeds on some swamp plant.

Type locality Maine. Type in Osborn collection. Type examined, also numerous specimens from Maine and New York.

Ophiola cuneata Sanders and De Long (Plates III, VIII and IX)

Euscelis cuneatus Sanders and De Long, Bull. Bur. Plant Industry, Penna., Vol. III, No. 15, p. 17, 1920.

Shorter and more wedge shaped behind than *angustata* with a broad black band on vertex and with distinct genitalia.

Vertex slightly roundingly produced, almost parallel margined, half as long as wide between the eyes, slightly over one-half as long as pronotum. Elytra distinctly longer than pronotum.

Color: Vertex, pronotum, and scutellum greenish yellow. Vertex with black transverse band between eyes just back of ocelli. Elytra smoky subhyaline, nervures with yellowish tint. Front dark with several arcs of yellow, spot on clypeus, sutures, dark. Venter black except ventral lateral thirds of last segment. Ovipositor black.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles pointed, posterior margin strongly concavely hollowed either side of a dark, median obtuse tooth. Male valve short, broadly rounding; plates triangular, three and a half times longer than valve, enlarged at base, tapering gradually to acute tips.

In both external and internal genitalia as well as other structural characters, this species appears to belong in this group, although formerly placed with *striolus*.

Present records indicate its distribution east of the Alleghenies, in Ohio and North Carolina. It doubtless is more widely distributed than collecting records would indicate as it is easily confused with the small form of *striolus*. De Long reports sweeping it from *Juncus*, small sedges, and *Cyperus diandrus* at Presque Isle, Pa.

Type locality Presque Isle, Pa. Type in Sanders and De Long collection. Specimens examined from Pennsylvania, New Jersey, New York and Ohio.

Ophiola symphoricarpae Ball (Plate III)

Athysanus symphoricarpae Ball, Can. Ent., XXXIII, p. 5, 1901.

Form of *striatula* but longer, more robust and with a rounding vertex. Length 4.5 mm.

Vertex broadly rounding, twice as wide between the eyes as long on middle. Pronotum twice as broad as long. Elytra longer than abdomen.

Color: Ocelli blood red, vertex pale testaceous with reddish transverse bands as in *striatula*. Pronotum and scutellum testaceous. Elytra testaceous subhyaline, nervures paler, lightly margined with fuscous. Front pale with remnants of eight pairs of dark arcs. Legs and venter pale straw.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles rounding, posterior margin almost truncate behind.

No male of this species was available for examination.

Described from specimens collected from Colorado and not since reported. Dr. Ball has designated *Symphoricarpos* as its food plant.

Type locality Ridgeway, Colorado. Type in Ball collection. Type examined.

Ophiola vara Ball (Plates III, VIII, and IX)

Athysanus varus Ball, Can. Ent., XXXIII, p. 5, 1901.

Resembling *symphoricarpae* in form and appearance but with a distinct color pattern. Length 4.5–5 mm.

Vertex obtuse, rounded sloping apex, one-half as long as width between eyes, twice as long on middle as against eyes. Pronotum one-third longer than vertex. Elytra exceeding abdomen.

Color: Vertex yellow washed with orange, a transverse band just back of ocelli, an interrupted one anteriorly and between ocelli, another close to posterior margin, fuscous. Pronotum irrorate with fuscous, scutellum with a pair of median tri-lobed spots. Elytral nervures pale, especially cross nervures, more or less margined with fuscous, cells irregularly fuscous. Front pale yellow with irregular arcs, spot at apex of clypeus, fuscous. Sutures dark. Venter dark.

Genitalia: Female last ventral segment half longer than preceding, lateral angles rounding, posterior margin truncate. Male valve nearly semicircular; plates long, triangular, three times length of valve, apices sub-acute, lateral margins slightly concave.

Described from specimens collected at Fort Collins, Colorado, and not since reported. Its food plant is as yet unknown.

Type locality Fort Collins, Colorado. Type in Ball collection. Specimens examined from type locality.

Although Dr. Ball has recently placed this species in the genus *Euscelis*, the writer believes it to be more closely related to the *Ophiola* group. The narrow and elongated appearance and the color pattern in the form of transverse bars on the vertex suggest *Ophiola*. Also, there is apparently a much closer correlation of the internal genital structures of this species with the external structures of the *Ophiola* group than with those of the *Euscelis* group.

When the host plant has been definitely determined this species should be placed with greater certainty.

Ophiola striatula Fallén (Plates III, VIII, and IX)

Cicada striatula Fallén, Hem. Suec., Cicad., p. 45, 1926.
Athysanus striatulus Fallén, (or *vaccinii* Van Duzee), Ent. Amer., VI, p. 134, 1890.
Euscelis vaccinii Van Duzee, Cat., p. 659, 1917.

An olivaceous yellow species common to both Europe and North America.

Vertex obtusely angled, one-half as long on middle as wide between the eyes, two-thirds as long as pronotum. Elytra narrow and distinctly longer than abdomen.

Color: Vertex olivaceous yellow with definite markings as in *arctostaphyli.* Elytra testaceous subhyaline, nervures whitish with olive tint, heavily margined with fuscous. Front dark with faint arcs of olive yellow. Legs pale. Venter dirty yellow.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles produced, bluntly acute, posterior margin slightly roundingly produced. Male valve broadly convexly rounding; plates triangular two and one-half times longer than valve, apices blunt.

Species extremely variable in size and coloration. The markings may be distinct, faint, or entirely lacking. The legs may be twice annulate with pale or entirely pale. The elytral nervures may be heavily, lightly, or not at all margined with fuscous. The genital characters are constant, specific internally but not externally. American forms compared with European forms with which they agree.

A species common to both Europe and North America. Its distribution extends from Maine westward to Iowa and Colorado, south to New Jersey and Maryland, northward into Ontario. Occurs in the *vaccinium* bogs of Northeastern United States and the higher meadows of the Rocky Mountains.

Type probably in Stockholm Museum. A great many specimens were examined from numerous diverse localities.

Ophiola striatula var. *cacheola* Ball

Ball, Bull. Brooklyn Ent. Soc., Vol. XXIII, No. 4, p. 189, 1929.

The following is the original description: "Resembling *striatula* in form and structure but much darker. Shining black with seven spots in two transverse rows on vertex, three in front and four behind. Six irregular spots on the anterior submargin together with numerous dots on the disc of the pronotum, white. The apices of the claval nervures, the cross nervure between sectors and sometimes the adjoining nervures, white. Face and below black. A few dots on lower part of face and the apices of the anterior and middle femora yellow.''

Type locality top of Wasatch Range near Logan, Utah. Type in Ball collection.

No example was available for examination.

Ophiola osborni Ball (Plates III, VIII, and IX)

Ball, Brooklyn Ent. Soc., Vol. XXIII, No. 4, p. 190, 1928.

Form and general appearance of *symphoricarpae* but slightly smaller and darker in color. Length 4–4.5 mm.

Vertex one-half as long on middle as wide between eyes. Pronotum twice as long as vertex.

Color: Ocelli blood red, vertex with reddish tint and with definite markings as in *symphoricarpae.* Elytra testaceous, subhyaline, nervures pale, heavily bordered with fuscous. Front dark with faint arcs of orange. Femora usually dark to near the apices, then orange as are the tibia. Venter dark as are the pygofers.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles bluntly rounding, posterior margin slightly roundingly produced. Male valve obtusely rounding; plates triangular, two and one-half times longer than valve, apices blunt.

Common on the dry uplands of Northeastern United States, extending from Maine westward to Montana and Colorado, southward to Maryland and northward into Ontario. Nothing is known regarding the food plant.

Type locality Ames, Iowa. Type in Ball collection. Numerous specimens from many states were examined.

Ophiola luteola n. sp. (Plates III, VIII, and IX)

In size and form resembling *striatula* but with greenish hyaline elytra and distinct genitalia. Length 4.5–5 mm.

Vertex obtusely angled, one-half as long on middle as wide between the eyes. Pronotum twice as broad as long. Elytra exceeding abdomen.

Color: Vertex bright greenish yellow with three transverse bands, the two posterior ones faint and more or less interrupted. Elytra greenish, nervures pale. Front pale yellow with about eight arcs of dark fuscous, sutures dark. Venter dark, except last two segments in female, yellow. Legs pale. Male without markings.

Genitalia: Female last ventral segment one-half longer than preceding, posterior margin slightly roundingly produced, lateral angles strongly acutely produced. Male valve obtusely triangular; plates triangular, two and one-half times longer than valve, tips acute.

Described from one female and one male collected at Wareham, Mass., and now in collection of Dr. D. M. De Long.

Ophiola comptoniana Ball (Plates III, VIII, and IX)

Ball, Brooklyn Ent. Soc., Vol. XXIII, No. 4, p. 189, 1928.

Resembling *striatula* in size and color pattern but distinguished by the much more angled vertex. Length 4.5 mm.

Vertex distinctly angled, almost right angled, two-thirds as long as wide between the eyes, twice as long on middle as against eyes. Pronotum almost one-half longer than vertex. Elytra distinctly longer than abdomen.

Color: Vertex olive yellowish with definite fuscous markings as in *striatulus*, paler. Pronotum and scutellum yellowish with irregular markings of fuscous. Elytra tawny, nervures pale, lightly margined with fuscous. Front tawny with pale arcs of yellow. Sutures dark. Venter and legs pale dirty yellow.

Genitalia: Female last ventral segment long as preceding, posterior angles slightly acutely produced, posterior margin almost truncate. Male valve rounding; plates triangular, two and one-half times longer than valve, tips blunt.

Described from specimens collected at Roselle Park, New Jersey. It has also been collected in Pennsylvania (Sanders). Ball reports collecting both adults and nymphs from *Comptonia peregrinus* (sweet fern).

Type locality Roselle Park, New Jersey. Type in Ball collection. Specimens examined from type locality, also from New York and Pennsylvania.

Genus *Commellus* Osborn and Ball
Plates I, VI, and IX

Commellus Osborn and Ball, Ohio Nat., II, p. 245, 1902.

Vertex produced in front of eyes, flattened above, acutely angled with front, not conical. Elytra slightly shorter or distinctly longer than abdomen. Venation irregular, second cross nervure often present. Form broad and stout.

Type of genus *Athysanus comma* Van Duzee.

Species conspicuously marked with longitudinal stripes. Female segment always deeply excavated, incised at apex and with underlying membrane conspicuous. Apices of male plates very broad.

Key to Species of *Commellus*

1. Two pairs of spots common to vertex and front, stripes on pronotum, black. Venation of elytra obscure	2
One pair of spots common to vertex and front, stripes on pronotum indistinct and interrupted, venation of elytra distinct	*sexvittatus* V. D.
2. Elytra with four separate stripes	*comma* V. D.
Elytra with eight separate stripes	*colon* O. & B.

Commellus comma Van Duzee (Plates I, VI, and IX)

Athysanus comma Van Duzee, Can. Ent., XXIV, p. 114, 1892.

A broad stout species, creamy white with fulvous brown markings. Length 4.5–5 mm.

Vertex obtusely angular, margin thick, rounding to broad front, two-thirds as long on middle as wide between the eyes, almost as long as pronotum. Frontal suture distant from the eyes, sides narrowing regularly to clypeus. Elytra exceeding or shorter than the abdomen.

Color: Pale creamy, four spots equally on vertex and face, a pair at base of vertex, black; pronotum and scutellum with four parallel longitudinal black stripes. Elytra creamy, a broad fulvous brown band extending around within margins, broader behind, bifurcating anteriorly to become confluent with stripes on pronotum, a broad brown band on claval suture and another, narrower, on inner branch of first sector. Front pale with a pair of spots below antennae and another pair on lateral margins of pronotum. Legs and venter pale.

Genitalia: Female last ventral segment distinctly longer than preceding, obliquely sloping on lateral margins, posterior margin deeply concavely excavated, dark margined apical slit, underlying membrane exposed at apex. Male valve large, triangular; plates twice longer than valve, convexly rounding at base, narrowing to middle, then parallel margined to broad truncate apices, equaling the pygofers. Internal genitalia distinct and illustrated.

This species is known to occur in Iowa, Nebraska, Kansas, Colorado, New Hampshire, and New York. Its host plants according to Osborn and Ball are *Elymus canadensis* and *E. striatus*. It has also been reported on Buffalo grass (De Long).

Type locality Iowa. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection. Numerous specimens examined from Iowa, New York and Nebraska.

Commellus colon Osborn and Ball (Plates I, VI, and IX)

Athysanus colon Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 223, 1897.

Similar to *comma* but elytra with different color pattern and venation. Length 4.5–5 mm.

Vertex obtusely angular, two-thirds as long on middle as wide between eyes, almost as long as pronotum. Inner branch first sector forking again to form long anteapical cell.

Color: Vertex, pronotum, and scutellum with spots and stripes as in *comma;* elytra with eight fulvous brown stripes. A continuous stripe just outside the first sector, one near the claval suture, and another median in the clavus, confluent with the outer stripe on the pronotum, a stripe between branches of first sector, a short stripe between branches of its inner fork, an interrupted one between the first and second sectors, one on the outer apical half of the clavus and another on the basal half, confluent with inner stripe on pronotum.

Genitalia: Posterior margin of female segment more deeply excavated than in *comma*, pygofers distinctly longer than plates. Internal genitalia distinct and illustrated.

The eight reddish-brown stripes on each elytron appears to be a good and constant character for separating this species from *comma.*

Occurs commonly on the prairies of Iowa and southern Minnesota where Osborn and Ball report taking it from *Stipa spartea.*

Type locality Ames, Iowa. Type in the Agricultural College collection, Ames, Iowa. Type examined, also numerous specimens from type locality.

Commellus sexvittatus Van Duzee (Plates I, VI, and IX)

Athysanus sexvittatus Van Duzee, Can. Ent., XXVI, p. 93, 1894.

In form and structure similar to *comma* and *colon,* but distinguished by color and wing venation. Brachypterous form. Length 4 mm.

Vertex obtusely angular, slightly wider between the eyes than long on the middle, as long as pronotum. Venation of elytra irregular, two or more cross nervures between sectors and usually two anteapical cells.

Color: Rusty yellow, vertex with a pair of shining black spots on apex, two pairs of quadrate spots posterior to these, tendency to become confluent, dull brown, six faint, irregular stripes on pronotum, the two median ones extending onto the scutellum. Elytra brownish subhyaline, nervures broadly pale, usually distinct, irregularly margined with fuscous. Front pale fuscous with faint arcs of yellow, sutures dark, legs and venter pale with light fuscous markings.

Genitalia: Female last ventral segment longer than preceding, posterior margin deeply excavated and incised at apex as in *colon,* exposing triangular lobe of underlying membrane. Male genitalia as in *comma* and *colon.* Internal genitalia distinct, illustrated.

Described from specimens collected from Colorado and since collected from Kalispell, Montana (Osborn), where it was swept from a tall red-top grass in rocky broken areas.

Type locality Colorado. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection. Specimens examined from type locality and Montana.

Genus *Stirellus* Osborn and Ball

Plates IV, VI, and IX

Stirellus Osborn and Ball, Ohio Nat., II, p. 250, 1902.

Vertex conically produced, narrow, longer on middle than width between eyes, disc convex, sloping and merging indistinctly with front. Species small. Elytra broad and short, venation simple. Ovipositor exceeding pygofers.

Type of genus *Athysanus bicolor* Van Duzee.

Key to Species of *Stirellus*

1.	Male plates little longer than valve, apices broad and very blunt, almost truncate...	2
	Male plates more than twice longer than valve, apices narrow and rounding, not truncate	*mexicanus* O. & B.
2.	Species greenish, large pair of dark spots on vertex, elytra with apical veins not distinct	*bicolor* V. D.
	Species brownish, 4 small spots on vertex, elytra with apical veins distinct and margined with dark fuscous........	*obtutus* V. D.

Stirellus bicolor Van Duzee (Plates IV, VI, and IX)

Athysanus bicolor Van Duzee, Can. Ent., XXIV, p. 114, 1892.

Similar to *obtutus* in size and general appearance, but with different color pattern and distinct genitalia. Length 3–3.4 mm.

Vertex acutely conically pointed, as long on middle as width between eyes. Elytra broad and short, rounding behind. Ovipositor greatly exceeding pygofers.

Color: Quite variable, vertex greenish yellow, a pair of black spots before middle, often confluent and covering anterior half, more often in male than female. Pronotum with dark band on anterior part, extending across base of elytra. Elytra bright greenish yellow to pale, with sutural margins, claval sutures, and apical margin dark fuscous. In male elytra often entirely fuscous, nervures indistinct. Front dark above with light band across lower half and base of clypeus. Venter dark.

Genitalia: Female last ventral segment as long as preceding, lateral margins, broadly rounding, posterior margin shallowly excavated, ovipositor greatly exceeding pygofers. Male valve triangular; plates but little exceeding the valve, convexly rounded to broad blunt apices, together almost semicircular, margins clothed with hairs.

A common meadow species, especially in southern localities, distributed from New Jersey and Maryland westward to Iowa, Kansas, and Nebraska, and southward into Cuba, Mexico, and Brazil. Osborn and Ball report it occurring normally on *Andropogon scoparius* but it undoubtedly occurs on a wide range of meadow grasses.

Type localities Mississippi and Emporia, Kansas. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection.

Numerous specimens examined from many localities, including Mexico and Cuba.

Stirellus obtutus Van Duzee (Plates IV, VI, and IX)

Athysanus obtutus Van Duzee, Can. Ent., XXIV, p. 115, 1892.

In size and form similar to *bicolor* but testaceous in color and with a different pattern. Length 3–3.5 mm.

Vertex angled, as long on middle as width at base. Elytra broad and short, rounding behind.

Color: Vertex pale testaceous with four spots between eyes, anterior pair often darker and larger than the posterior pair. Pronotum testaceous with a row of irregular spots on anterior margin, often confluent in a more or less transverse band. Elytra testaceous subhyaline, nervures pale. Face testaceous, often dark above, apex of clypeus dark fuscous.

Genitalia: Female last ventral segment scarcely as long as preceding, lateral angles rounding, posterior margin shallowly excavated, ovipositor greatly exceeding pygofers. Male valve triangular; plates convexly rounded, almost semicircular, but little exceeding valve.

A species widely distributed from Maryland as far west as Arizona and southward to the Gulf states. It occurs commonly in meadows, more abundantly on *Andropogon scoparius.* Professor Osborn also reports its feeding on Bermuda grass. There are probably three generations a year, the last one hibernating as an adult.

Type locality Mississippi. Type doubtful, in Agricultural College collection, Ames, Iowa, or in Cornell University collection.

A great number of specimens from diverse localities examined.

Stirellus mexicanus Osborn and Ball (Plates IV, VI, and IX)

Stirellus mexicanus (Osborn and Ball) Ohio Naturalist, Vol. II, p. 254, 1902.

Form of *obtutus* and *bicolor* but with male genital plates triangular in shape, not semicircular.

Vertex narrow, slightly longer than its basal width. Elytra long, reaching tips of the exserted ovipositor.

Color: Vertex yellow with pair of large black spots, often confluent in male. Pronotum and elytra greenish to yellowish brown. Face pale to dark with arcs of yellow.

Genitalia: Female last ventral segment long, ovipositor longer than in *bicolor*. Male valve triangular, apex acute. Plates triangular, apices rounding, over twice as long as valve.

This species has not yet been reported north of Mexico.

Type locality Orizaba, U. C. Mexico. Type in Herbert Osborn collection. Type examined.

Genus *Amplicephalus* De Long

Plates V and X

Amplicephalus De Long, Ohio State Univ. Bull. II, No. 13, p. 83, 1926.

Vertex very broad, width between eyes greatly exceeding length at middle, strongly rounded or very bluntly angled. Margin bluntly angled with front. Form broad and robust. Anteapical cell constricted and usually divided.

Type of genus *osborni* Van Duzee.

Key to Species of *Amplicephalus*

1.	Vertex broadly bluntly angled	*simplex* V. D.
	Vertex very broad, scarcely angled	2
2.	Female segment narrowly incised at middle, vertex with dark spot next either eye and a pair of elongated spots between these	*escalantus* Ball
	Female segment not incised at middle	3
3.	Female segment with short lateral margins, underlying membrane conspicuous at sides; male plates triangular with tips pointed	4
	Female segment normal, underlying membrane not conspicuous at sides; male plates concavely rounding to very broad blunt apices; broad black band on anterior margin of vertex	*estacadus* Ball
4.	Vertex, pronotum, and scutellum each with a pair of dark round spots in line	*lassus* Ball
	Vertex scarcely produced with four or six spots on anterior margin	*osborni* V. D.

Amplicephalus simplex Van Duzee (Plates V and X)

Deltocephalus simplex Van Duzee, Trans. Am. Ent. Soc., XIX, p. 304, 1892.

Athysanus simplarius Osborn and Ball, Ohio Nat., II, p. 249, 1902 (n. n. for *simplex* V. D.).

Deltocephalus (*Amplicephalus*) *simplex* De Long, O. S. U. Bull., Vol. II, No. 13, p. 83, 1926.

Amplicephalus simplex De Long and Sleesman, Ann. Ent. Soc. Am., Vol. XXII, No. 1, p. 96, 97, 1929.

Vertex bluntly angled, almost twice as long on middle as against eye, one-fourth broader than long, slightly shorter than pronotum. Elytra exceeding abdomen. Length 4–5 mm.

Color: Vertex straw yellow, often greenish yellow, a pair of approximate triangular spots at apex, a quadrate pair next either ocellus, black. Pronotum pale yellow, often pale greenish, unmarked. Elytra pale greenish yellow, nervures paler. Face straw colored with light brownish arcs. Venter straw yellow, ovipositor black.

Genitalia: Female last ventral segment as long as preceding. Lateral margins short, abruptly concavely rounded to posterior margin, exposing underlying membrane at sides. Posterior margin slightly concave and notched either side a short, blunt triangular median tooth. Male valve short, broadly rounding; plates three times as long as valve, broad at base, outer margins strongly concavely rounded to acute tips.

Distributed along the Atlantic coast from Connecticut to lower Virginia. Collected from Virginia on *Spartina patens* in a salt marsh (De Long).

Type localities Canton Marsh, Md., Astoria, L. I., and Hoboken, N. J. Type in Agricultural College collection, Ames, Iowa. Specimens examined from several localities.

Amplicephalus osborni Van Duzee (Plates V and X)

Deltocephalus osborni Van Duzee, Trans. Am. Ent. Soc., XIX, p. 304, 1892.

Athysanus osborni Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 220, 1897.

Deltocephalus (*Amplicephalus*) *osborni* De Long, O. S. U. Bull., Vol. II, No. 13, p. 84, 1926.

Amplicephalus osborni De Long and Sleesman, Ann. Ent. Soc. Am., Vol. XXII, No. 1, p. 96–97, 1929.

Vertex roundingly obtusely angled, two-thirds as long as wide between the eyes, pronotum almost as long as vertex, twice wider than long. Elytra exceeding abdomen, inclined to be flaring behind.

Color: Pale straw yellow, tawny, with varied markings, often indistinct. Vertex usually with four dark spots on anterior margin. Median pair longer and often confluent with those next the ocelli. Pronotum tawny with traces of five pale longitudinal bands. Elytra pale dirty yellow, nervures white, often margined with fuscous. Face pale with traces of light arcs. Venter straw yellow.

Genitalia: Female last ventral segment as long as preceding, lateral margins short, abruptly concavely rounded to posterior margins, exposing lobes of underlying membrane at sides. Posterior margin bisinuate, forming three rounding lobes, the median shorter. Male valve short, broadly rounding; plates triangular, three times as long as valve, gradually tapering to acute tips.

This species is widely distributed throughout Northeastern United States, extending from Maine to Colorado, Missouri, and Nebraska and almost as far south as the Ohio River. It occurs more abundantly in the Northern States.

No definite food plant is known, but it is common on tall grasses and sedges in marshy areas of the *Calamagrostis* meadow where a swamp or lagoon has receded (De Long).

Type locality Lancaster, New York. Type in Agricultural College collection, Ames, Iowa. Specimens examined from numerous localities.

Amplicephalus lassus Ball (Plates V and X)

Athysanus lassus Ball, Ent. News, XXVII, p. 175, 1916.

A rather robust brownish species distinguished by a pair of dark brown spots on vertex, pronotum and scutellum. Length 4 mm.

Vertex obtusely angled, slightly over one-half as long as basal width. Pronotum one-half as long as wide. Elytra exceeding abdomen.

Color: Vertex brownish yellow, a pair of small dots on apex, a pair of large round spots between these and ocelli, brown. Pronotum and scutellum each with a pair of brown spots on anterior margins. Elytra milky hyaline, nervures pale, occasionally claval and apical nervures lightly margined with fuscous. Face and venter pale.

Genitalia: Female last ventral segment length of preceding, lateral margin very short, concavely produced to posterior margin which is bisinuate, forming three broadly rounding lobes. Male valve obtusely rounding; plates triangular, outer margins slightly concave, tapering to acutely attenuated tips.

This species was described from Quincy, California, and since collected from Montana and Wyoming (Osborn). Nothing is known regarding its host plant.

Type locality Quincy, California. Type in Ball collection. Specimens examined from Montana and Wyoming.

Amplicephalus estacadus Ball (Plates V and X)

Athysanus estacadus Ball, Can. Ent., XLIII, p. 200, 1911.

Euscelis ozarcensis Gibson, Can. Ent., 42, p. 184, 1917.

A robust dark straw-colored species with a dark transverse submarginal band on vertex.

Vertex two-thirds as long on middle as wide between the eyes, obtusely angular.

Color: Vertex bright straw, a broad black band just back of anterior margin. Pronotum with a light, narrow, median transverse band. Elytra dark straw with light margins, nervures pale. Front fuscous with arcs of pale brownish yellow, sutures dark. Legs and venter dark with areas of pale fuscous.

Genitalia: Female segment twice longer than preceding, lateral margins rounding to the produced posterior margin. Male valve broadly convexly rounding; plates triangular, broad at base, convexly rounding to near middle, then concave, gradually narrowing to acute tips.

Described from Texas but it undoubtedly has a much wider distribution. It has been reported from Tennessee where it occurs abundantly on native grasses (De Long) and from Missouri (Gibson). *Euscelis ozarcensis* = *Amplicephalus estacadus* as Dr. Ball has recently pointed out.

Type locality Texas. Type in Ball collection. Specimens examined from type locality, also numerous specimens from Tennessee.

Amplicephalus escalantus Ball (Plate V)

Athysanus escalantus Ball, Ent. News, XXVII, p. 175, 1916.

Deltocephalus escalantus Van Duzee, Cat., p. 649, 1917.

Vertex obtusely angled, two-thirds as long as width between eyes. Pronotum twice as broad as long. Elytra only slightly exceeding pygofers.

Color: Vertex yellow washed with orange, a small submarginal spot against either eye, between these a narrow black band broken medianly. Elytra greenish subhyaline, nervures pale. Face pale straw with anterior margins and lateral sutures dark. Venter dark.

Genitalia: Female last ventral segment half longer than preceding, lateral angles subacute, posterior margin almost truncate, slightly excavated on median third, shallowly incised at apex.

Described from specimens collected from Richfield, Utah; and since collected from Yellowstone National Park by Professor Osborn.

Type locality Richfield, Utah. Type in Ball collection. Specimens examined from localities previously mentioned.

Genus **Amblysellus** Nov.

Plates IV, VI, and X

Vertex nearly right-angled, slightly wider between eyes than length on middle. Front broad at apex, triangular, narrowing regularly to the long clypeus. Elytra broad and short.

Type of the genus *Athysanus curtisii* Fitch.

Amblysellus curtisii Fitch (Plates, IV, VI, and X)

Amblycephalus curtisii Fitch, Homop. N. Y. State Cab., p. 81, 1851.

A small greenish yellow species distinguished by the angular vertex and the "Y" shaped figure on clypeus. Length 3.5 mm.

Vertex angular, almost right-angled, as long as width between eyes, twice as long on middle as against eyes. Elytra broad and short, not greatly longer than body.

Color: Vertex pale yellowish green, usually a pair of small black spots on apex, a pair of large shining spots between and a little in front of eyes, black. Anterior part of pronotum produced between the eyes, shining black, posterior part greenish yellow, narrowly margined with fuscous behind. Elytra testaceous, the margins and nervures greenish yellow. Front with irregular fuscous markings on apex, margins below eyes fuscous, joining a median mark on the clypeus, forming a "Y"-shaped figure. Venter dark.

Genitalia: Female segment longer than preceding, lateral margins roundingly narrowed, forming rounded lateral angles. Posterior margin slightly excavated either side a short rounded median lobe. Lobes of underlying membrane exposed at sides. Male valve roundingly triangular; plates triangular two and one-half times length of valve, tips acute, fringed with hairs.

A species widely distributed in Northeastern United States, extending southward to New Jersey and Tennessee and westward to Iowa and Missouri. It is common in blue grass meadows and grass woodlands where it rivals *D. sayi* in abundance.

Numerous specimens examined from a great many localities.

SPECIES REFERRED TO OTHER GENERA

Thamnotettix texanus Osborn and Ball (Plates V and X)

Athysanus texanus Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 92, 1898.

In size and form similar to *Th. fitchii* but distinguished by a pair of parallel, bright red stripes on the vertex, pronotum, and scutellum and distinct genital characters. Length, female 5 mm., male 4 mm.

Vertex obtusely angled, slightly longer on middle than width between eyes. Elytra exceeding abdomen.

Color: Vertex pale yellow, a narrow black line on anterior margin, a pair of black spots near apex and a pair of broad, longitudinal, bright red stripes running parallel on vertex, pronotum, and scutellum. Three pairs of red stripes on elytra, the inner pair confluent with those on scutellum. Face bright mahogany. Venter pale.

Genitalia: Female last ventral segment one-half longer than preceding, lateral margins short, abruptly concavely rounded to produced posterior margin. Underlying membrane exposed at sides in form of lobes. Male valve broadly convexly rounding, plates triangular, much broader than valve at base, gradually narrowing to acute tips, thickly clothed with long hairs.

This is the first time that a male of *Euscelis texanus* has been described. Although Dr. Ball has recently placed this species in the Genus *Commellus,* the writer feels that it is apparently much more closely related to *Thamnotettix fitchii* than to any of the species in the *Commellus* group. Externally these two species appear to be quite similar. Also, the internal genitalia indicate a close relationship. The styles are of the same general type, the chief difference being in the terminal processes, which are much more acutely produced in *fitchii.* The oedagi are quite similar. In a ventral view they are comparatively long and narrow, the apices shallowly concavely hollowed. In a lateral view the oedagus in *texanus* is more strongly curved and of a slightly different contour than in *fitchii.* In both species the oedagi are quite broad at the base, narrowing abruptly at about two-thirds their length to near the apices, which are broadened spatulate-like. The style-oedagus connectives are almost identical.

This species is known only from Louisiana and Texas.

Type locality Aaron, Texas. Type in Agricultural College collection, Ames, Iowa. Type examined, also specimens from Louisiana.

Deltocephalus dentatus Osborn and Ball

> *Athysanus dentatus* Osborn and Ball, Proc. Dav. Acad. Sci., Vol. VII, p. 95, 1898.

> Resembling *fuscinervosus* in form and appearance, but shorter, more robust, and with distinct genitalia. Length 3 mm.
>
> Vertex obtusely rounding, less than twice as long as basal width. Elytra as long as abdomen and inclined to be flaring.
>
> Color: Vertex pale straw, a distinct spot along anterior margin, a pair of oblique "V" shaped marks on disc, their inner arms united anteriorly. Pronotum pale straw with a distinct pair of round spots on anterior margin. Scutellum with a pair of spots on disc in line with those on pronotum. Elytra pale testaceous, subhyaline, nervures paler. Face pale testaceous with arcs of dark. Legs pale, venter dark. Ovipositor black.
>
> Genitalia: Female last ventral segment as long as preceding, lateral margins short, abruptly concavely rounded to long, produced, blunt tips, between which posterior margin is slightly produced in two rounding lobes. Underlying membrane exposed at sides.

This species does not fall readily into any of the above groups. Although it appears to be closely related to *D. fuscinervosus,* it cannot be placed with any great degree of certainty until a male is at hand for examination.

Described from specimens taken in Colorado and since collected in Wyoming and Kansas (Osborn).

Type locality Colorado. Type in Agricultural College collection, Ames, Iowa. Type examined, also specimens from Wyoming and Kansas.

A COMPARATIVE STUDY OF THE INTERNAL GENITALIA AND THEIR BEARING UPON TAXONOMY

Several problems in taxonomy and relationship have presented themselves during the course of this study. The present discussion and figures are an attempt to throw more light upon the relationship by presenting the structures and data which will assist in solving some of the problems and establishing certain taxonomic relationships, as well as a critical study of the divisions made in present and previous studies.

All genera which have been previously established are confirmed in this study. One additional genus is established and one is removed from the *Deltocephalinae* and included in the *Euscelinae*.

In all of the groups except two, good specific characters are present. In these two groups, *Ophiola* and *Striellus,* it is apparent that in several of the species there is very little differentiation in genital characters, either external or internal.

Genus *Remadosus* Ball
Plates VI and IX

The two species included in this genus to date are very similar externally and can be readily separated only by a color character. An examination of the internal genitalia indicates a very close relationship. The styles are very similar and show no specific differences. The oedagi in a side view present the only constant specific characters which are found in the terminal portions. In *magnus* the apical portion is very acutely produced and a ventral spur is given off near the apex which curves posteriorly. In *fumidus* the terminal portion curves abruptly dorsally and posteriorly to the acute apex. The internal genitalia of *drakei* are identical with *fumidus* and as there appears to be specific external structural differences, *drakei* is here considered as a synonym of *fumidus.*

Genus *Drylix* Edwards
Plates VII and IX

This genus contains a number of species which are very similar in external appearance and are readily separated only by the external genital characters. A study of the internal genitalia also indicates that the species are very closely related.

The styles are of the same general type. The chief difference seems to be in the length and shape of the terminal processes. In *striolus* the terminal portion is comparatively long and narrow while in the remaining species it is much shorter and broader, the apex is very blunt in *truncatus*.

An examination of the oedagi in a side view would show that the members of the group are very similar in general type. *Striolus* has an oedagus which is very broad at the apex and of a slightly different shape than is found in the other members of this genus, yet it undoubtedly shows a close relationship. *Parallelus* and *truncatus* are very similar, differing chiefly in the length and curvature of the apical portions. In *uneolus* the apex is not deeply bifurcate and curves anteriorly instead of posteriorly as in *parallelus* and *truncatus*. An anteriorly directed process of varying shape is articulated with the oedagus in each species.

In ventral view the oedagi show specific differences and in one case unique differences. *Striolus* has an oedagus which appears to be produced dorsally, the dorsal surface being much broader than the ventral surface. The apex appears scarcely bifurcate. The essential difference between *parallelus* and *truncatus* appears to be in the length and breadth of the bifurcate apices, which curve outwardly. In *uneolus* the apex is not deeply bifurcate and the tips curve inwardly.

In *divaricatus* the style is unique for the group. The terminal process is extremely long and acutely produced. It is slightly curved outwardly and a knot-like swelling appears on the inner margin. In a side view the terminal process is directed dorsally at a right angle. The oedagus in ventral view is short and broad, narrowed and concavely hollowed at the base. Also a pair of sharply produced processes project outwardly near the middle.

Genus *Exitianus* Ball
Plates VI and X

Obscurinervis, the only species placed in this genus to date, is probably of South or Central American origin and is structurally very distinct. The internal genital characters are also unique. From a ventral view the style is broad at the base, the lateral margins acutely produced. The terminal process is comparatively long and curves abruptly laterally, almost at a right angle. The apex is acutely produced. The oedagus is very broad at the base, the lateral margins produced anteriorly. In a side view the basal portion of the oedagus is prolonged dorsally, while the body curves dorsad and cephalad, the apex appearing rather blunt.

Genus *Athysanus* Burmeister

Plates VI and X

Only two species remain in this genus, one of which was available for study. In *frigidus* the internal genitalia are of a rather simple type. The style is not greatly different from the type found in the other groups, broad at the base and tapering to the blunt apex. The terminal process is rather broad and slightly curved laterally. The oedagus in ventral view is relatively short and broad while in a side view it curves dorsally and anteriorly, the apex bifurcate, tips acute. An anteriorly directed process is articulated with the basal dorsal prolongation of the oedagus.

Genus *Euscelis* Brullé

Plates VII and IX

Externally the species of this genus appear very similar and indicate a close relationship. In several cases there has been some doubt as to the specificity of certain forms, but a study of the internal genitalia, although undoubtedly indicating a very close relationship, show sufficient differences in structure to separate them easily.

An examination of the oedagi shows two rather distinct types to which the species belong. In one of the groups we might place *alpinus, obsoletus, deceptus,* and *relativus.* The oedagi in all of these species are very similar. From a ventral view the oedagus is relatively broad at the base, but narrows abruptly, tapering gradually to the apex. In *alpinus* the oedagus is of a very generalized type while *obsoletus* shows a further development in being bifurcate at the apex. In *deceptus* and *relativus* the oedagi are very similar, the apical portion in each is expanded laterally. In a ventral view the oedagus of *relativus* is constantly much broader and the lateral margins are distinctly concavely hollowed for about half their length. From a side view the body of the oedagus in *deceptus* appears smooth and the apical portion seems to be produced hooklike. In *relativus* the dorsal surface of the oedagus just posterior to the basal dorsal prolongation is produced in a spine-like process. The connectives are also different specifically. Although undoubtedly closely related, these two forms appear to show constant specific differences. In the second group we might place *extrusus* and *ovatus* which are very similar in structure. *Extrusus* is much larger than *ovatus* and the external genital characters seem to be specific. The style-like posterior productions of the pygofers also present good specific external characters for separation. The oedagi are very similar, broad at the base, the basal angles rounding in *extrusus*, acutely produced in *ovatus*. The oedagus bifurcates very near the base and curves dorsally in a slightly different manner in these two forms. At the base of the bifurcations a median process is given off which also curves dorsally, which in *ovatus* is much shorter and more acutely produced. The connectives are also different specifically. The styles probably show less variation than the other structures, although specific in most cases.

Genus *Ophiola* Edwards
Plates VIII and IX

The examination of the external structures of the species of this genus would indicate these species are very closely related. In fact in several cases there has been some question as to the specificity of certain forms. The external genital characters are almost identical throughout the group and entirely lacking in specific characters. An examination and study of the internal genitalia has led to the same conclusion, namely, that these species are very closely related.

The styles of the members of this group, with the exception of one or two species are of the same general type. The terminal portions are relatively long and bluntly terminated, varying slightly in width and curvature. *Luteola* has a style which is very slightly produced at the base and tapers gradually to the blunt terminal portion which does not appear definitely as a process. In *cuneata* the terminal process is short and roundingly produced while in *angustata* the style is of slightly different shape and the terminal process is short and strongly curved.

An examination of the oedagi in side view shows that the members of this genus are very similar in general type. At the base the oedagus is directed dorsally and slightly anteriorly, similar in shape in all species examined except *luteola*. An anteriorly directed process is articulated with this dorsal prolongation of the oedagus which is specific in several cases. The oedagi in *humida, arctostaphyli, comptoniana, shasta, cornicula, uhleri, anthracina, vara,* and *osborni* are very similar in size and shape. The oedagus is deeply cleft at its terminal portion, appearing bifurcate. In *humida, arctostaphyli, comptoniana,* and *osborni* the lateral margins are concavely produced to near the middle, then abruptly concavely rounded to acute divergent apices, while in *shasta* the lateral margins are convexly rounding to tips. In *humida* the body of the oedagus is constantly much shorter and narrower than in *arctostaphyli* while in *comptoniana* the terminal portion is much longer and more produced. The terminal portions of the oedagus of *uhleri* are broad to very near the apices, then abruptly narrowed to acute tips, while in *anthracina* the body of the oedagus is very broad, the terminal processes overlapping one another. *Cornicula* shows a further development in that a pair of short lateral processes are present on the terminal portions of the oedagus, which from a ventral view appears bifurcate. In *vara* the lateral margins are produced near the center in a spine-like process which curves forward. The process at the base of the cleft is much longer than in the other members of this group and the tips are not divergent. In *striatula, luteola, cuneata,* and *angustata* the body of the oedagus is shorter and more shallowly cleft, the terminal portion simple in *angustata, cuneata,* and *luteola,* while in *striatula* the apical portions are expanded laterally at the tips, the anterior margin at the base of the cleft also produced broadly spine like. *Luteola* is unique in that the basal portion of the oedagus is acutely produced in a second dorsally directed process.

Genus *Commellus* Osborn and Ball
Plates VI and IX

An examination of the external structures of the species of this genus would indicate that these species are very closely related. Within the genital chamber the sides of the pygofers appear to be produced in long spine-like processes which also are good specific characters.

The oedagus is rather short and relatively broad. From a ventral view the apical portion of the oedagus appears bifurcate and rests on a rectangular structure, which in *comma* is comparatively long and slightly constricted antero-posteriorly while in *colon* it is constantly shorter and more strongly constricted. From a side view the anterior margin of this structure in *comma* is produced ventrally in a short, bluntly terminated spine like process. In *sexvittatus* the oedagus from a ventral view appears to rest on a pair of elongated structures which are not connected medianly. Attached to these median structures are broad bulb-like, posteriorly directed processes which show good specific differences in each case. From a side view the anterior portions of the oedagi in *comma* and *colon* are produced ventrally and postero-dorsally, apparently attached to ventral surface of the median structures. In *sexvittatus* the oedagus is produced ventrally and posteriorly between the styles. The posterior processes extend as far as the posterior margin of the anal ring to which they are generally attached by means of the surrounding membrane. The styles are of the same general type, showing no specific differences in *comma* and *colon.* In *sexvittatus* the basal and apical processes are much heavier and bluntly rounding.

Genus *Stirellus* Osborn and Ball
Plates VI and IX

Both of the species that have been placed in this genus are meadow feeders and occur most abundantly in southern localities. *Bicolor* is probably of subtropical origin. The internal genitalia are very unique, yet similar and exhibiting no specific differences. Although undoubtedly closely related, these two forms, *obtutus* and *bicolor,* are quite distinct externally.

Mexicanus, a species not yet found north of Mexico, has a similar type of genitalia, almost identical with the two forms mentioned above.

Genus *Amplicephalus* De Long
Plates V and X

Six species have been placed in this genus to date. Four of these, *osborni, simplex, estacadus,* and *lassus,* have been available in sufficient numbers for a study and examination of the internal genitalia. The styles are quite similar, although specifically different. In *simplex, lassus,* and *estacadus* the styles are broadest at the base, tapering to the apex, while in *osborni* the style is broadest at the middle. In *osborni, estacadus,* and *lassus* the oedagi are quite similar, especially from a ventral view, where the chief differences appear to be in the width of the tip and the length and depth of the concavity between the outer apices. From a lateral view there is considerable difference in the shape and width of the tip and the position and direction of the basal dorsal spur. In *estacadus* the dorsal surface of the oedagus just posterior to the dorsal basal spur appears to be slightly concavely hollowed and produced in a short spine.

Genus *Amblysellus* nov.
Plates VI and X

In *curtisii,* the only species placed in this genus to date, the genitalia are quite distinct. The style-oedagus connective is long and broad. The styles are triangular in shape and the terminal processes are heavy and much produced. The oedagus in a ventral view appears long and narrow, tapering at the apex, which appears concavely hollowed. In a side view the oedagus is broad at the base, abruptly and strongly narrowing at about half the length, the apex curving upward.

BIOLOGY

At the present time very little is known regarding the biology of this genus. Osborn and Ball have made many valuable observations and records on the life history of certain members of this group during their work in Iowa. The data is readily accessible in several bulletins[1] and will not be repeated here.

ECOLOGY

The relation of plant associations to insects is steadily receiving more attention by present day workers. Within each of the climatic formations of North America there are a number of edaphic formations. Each of these edaphic formations is composed of plant associations which are related to each other as successional series correlated with gradual changes in the environment. With these changes in the environment insect successions occur which bear a definite relationship to plant associations. In a particular plant association certain species of insects tend to reproduce most abundantly. It has been pointed out that this is true for animals which feed directly on plants and those that do not. Therefore, it would be logical to assume that the combination of habitat factors which enables the particular plant association to develop and persist

[1] Osborn and Ball, Ia. Agr. Coll. Expt. Sta. Bull. XXXIV, p. 630, 1897; Osborn, U. S. D. A., Div. Ent., Bull. 108, 1892.

also present the most favorable set of environmental conditions for the reproduction of certain species of animals. When a particular host is used as a source of food by a certain species of insect, such a specialization is a limiting factor in the distribution of the species concerned. Students of particular species of insects, desiring an abundance of material, will save much time and labor by thinking in terms of plant association such as swamp, bog, meadow, *et cetera,* where experience has shown the species to reproduce abundantly.

Little detailed data is available in regards to the habits of the species of this group but the many observations of certain workers permit certain species to be grouped according to the type of habitat into prairie, swamp, bog, and meadow forms.

Prairie and Plains Formation

Comparatively few of the species of the genus occur on the prairies. Such forms as *comma* occur on *Buchloe, Elymus canadensis* and *E. striatus* and *colon* on *Stipa spartea. Magnus* is widely distributed through the prairie region on *Spartina michauxiana.* According to Osborn and Ball *obtutus* and *bicolor* occur normally on *Andropogon scoparius,* but at present have a much wider range of host plants and are not confined to the prairie regions.

Alpine Meadow Formation

Alpinus is the only species which is known to occur in the damp mountain meadows of Alpine regions.

Fresh Water Swamp Formation

Several of the species of this group are known to be definitely associated with the fresh water marsh formation. *Parallelus, cuneata, striolus,* and *divaricatus* occur on *Juncus, Elocharis* and small sedges along the margins of comparatively young lagoons. *Parallelus* also occurs abundantly in old lagoon basins while *striolus* occurs commonly on the Carex-Phragmites association which merges with wet meadows. *Cornicula* occurs on short grasses on marshy areas, while *extrusus* is at hand in marshy areas and low swampy places.

Bog Formation

Several species occur commonly in bogs. *Striatula* and *cornicula* occur in boggy associations including *vaccinium. Uhleri* and *humida* also are commonly found in boggy situations.

Moist Meadow Formations

Many species of this group are grass feeders and occur commonly in meadows and pastures. *Curtisii* is very abundant in blue grass meadows, *obscurinervis* is a widely distributed species and occurs on many grasses. *Obtutus, bicolor,* and *estacadus* are among other common meadow forms.

Anthracina and *uhleri* are quite commonly taken from high dry pastures.

Salt Marsh Formation

Three species are definitely known to occur in Salt Marsh Formation. *Simplex* is found as a rule upon *Spartina patens,* both nymphs and adults having been taken in abundance upon this plant. *Magnus* has been taken in abundance in both nymphal and adult stages from *Spartina patens. Funidus* occurs on a *Spartina-Rynchospora* association, but which plant is the true host is not definitely known.

ECONOMIC

Leafhoppers are undoubtedly of much more economic importance than the average entomologist is willing to concede. The potato, grape, and beet leafhoppers have demanded attention, but little has been given the grass feeding species. Provided with a minute beak designed for sucking, these small insects, scarcely observed, puncture the plant tissues, sucking the juices and draining the plant of its vitality. Unless passing the point where the constant drain causes wilting and withering, the injury is unnoticed, yet it results in lowered yield and less available pastures. Professor Osborn has estimated as many as one and a half millon per acre of grass land.

Many of the species of this group are grass feeders and where occurring in sufficient numbers are to be considered of economic importance. Chief among the grass feeders are *obscurinervis, curtisii, obtutus, bicolor,* and *extrusus. Obscurinervis* and *curtisii* very commonly attack grains in sufficient abundance to cause considerable damage.

The best control measure known at present is the practice of clean farming. Burning the fields and fencerows during the winter is very effective. When fall grains are open to attack Professor Osborn advises burning the fields in late September. Rotation of pastures and meadows is a very good practice, as a two- or three-year-old pasture furnishes ideal breeding places. Osborn and Ball also found that cutting the grass just after the eggs have been deposited resulted in the eggs being crushed by the wilting and drying of the plant.

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Explanation of Plates

Plate I

Dorsal view of head and ventral view of female genitalia of species of Genera *Remadosus, Commellus,* and *Drylix.*

Plate II

Dorsal view of head and ventral view of female genitalia of species of Genera *Euscelis* and *Athysanus.*

Plate III

Dorsal view of head and ventral view of female genitalia of species of Genus *Ophiola.*

Plate IV

Dorsal view of head and ventral view of female genitalia of species of Genera *Ophiola, Exitianus, Stirellus,* and *Amblysellus.*

Plate V

Ventral and lateral view of internal male genitalia (top) *in situ.* Genus *Amplicephalus,* also *texanus* and *Thamnotettix fitchii.*

Dorsal view of head and ventral view of female genitalia (lower) of species of Genus *Amplicephalus.*

Plate VI

Ventral and lateral view of internal male genitalia *in situ.* Genera *Remadosus, Commellus, Stirellus, Amblysellus, Exitianus,* and *Athysanus.*

Plate VII

Ventral and lateral view of internal male genitalia *in situ.* Genera *Drylix* and *Euscelis.*

Plate VIII

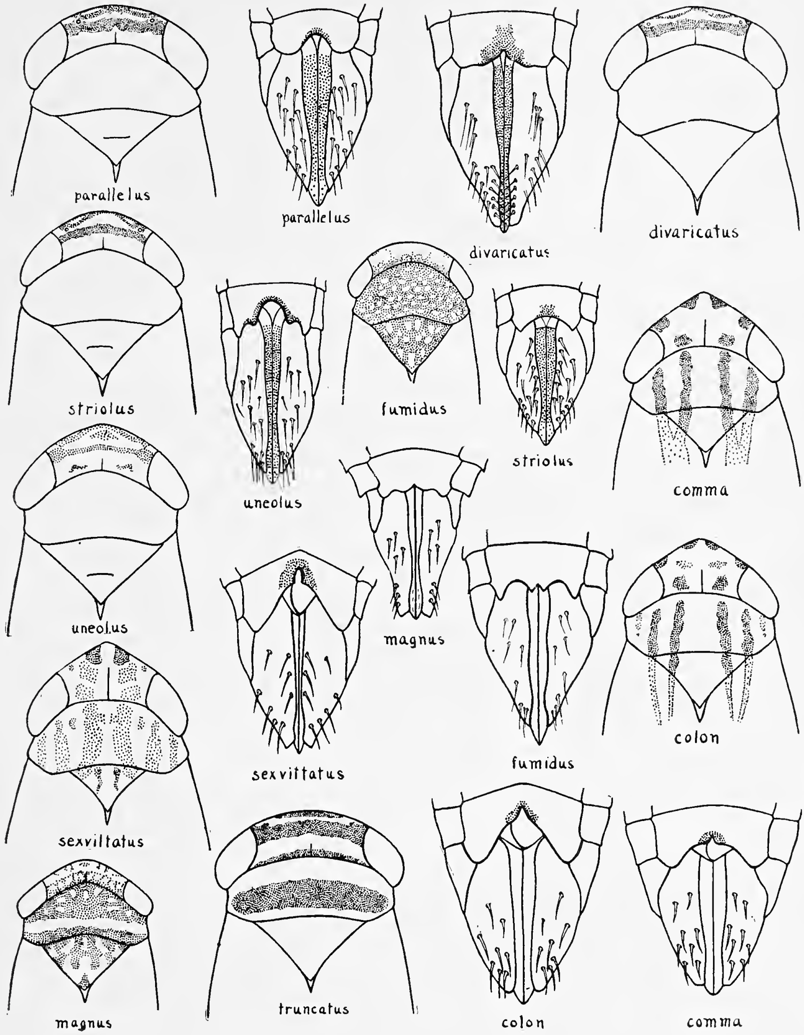
Ventral and lateral view of internal male genitalia *in situ.* Genus *Ophiola.*

Plate IX

Comparative view of oedagi, ventral and lateral aspects, of Genera *Ophiola* (top), *Drylix, Commellus, Euscelis* (middle), and *Stirellus* (bottom).

Plate X

Comparative view of oedagi, ventral and lateral aspects (top), of Genera *Amplicephalus, Remadosus, Athysanus, Amblysellus,* and *Exitianus.* Also *texanus* and *Thamnotettix fitchii.* Comparative view of styles (lower) of all Genera.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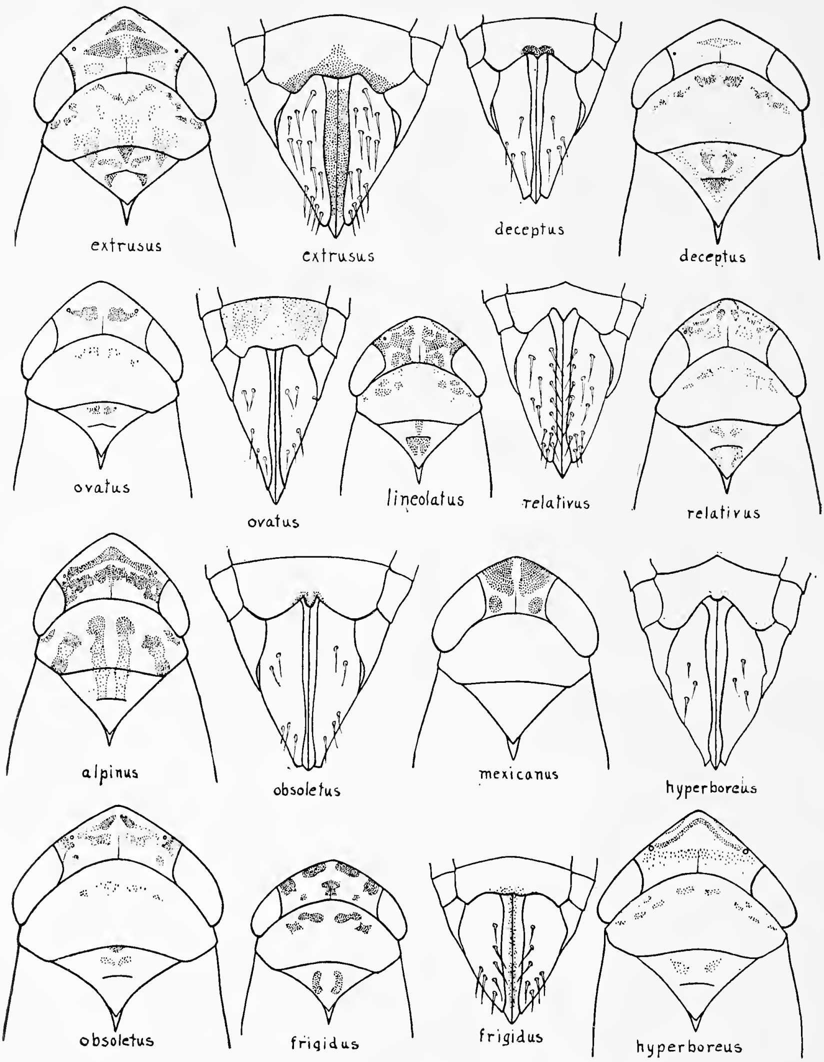
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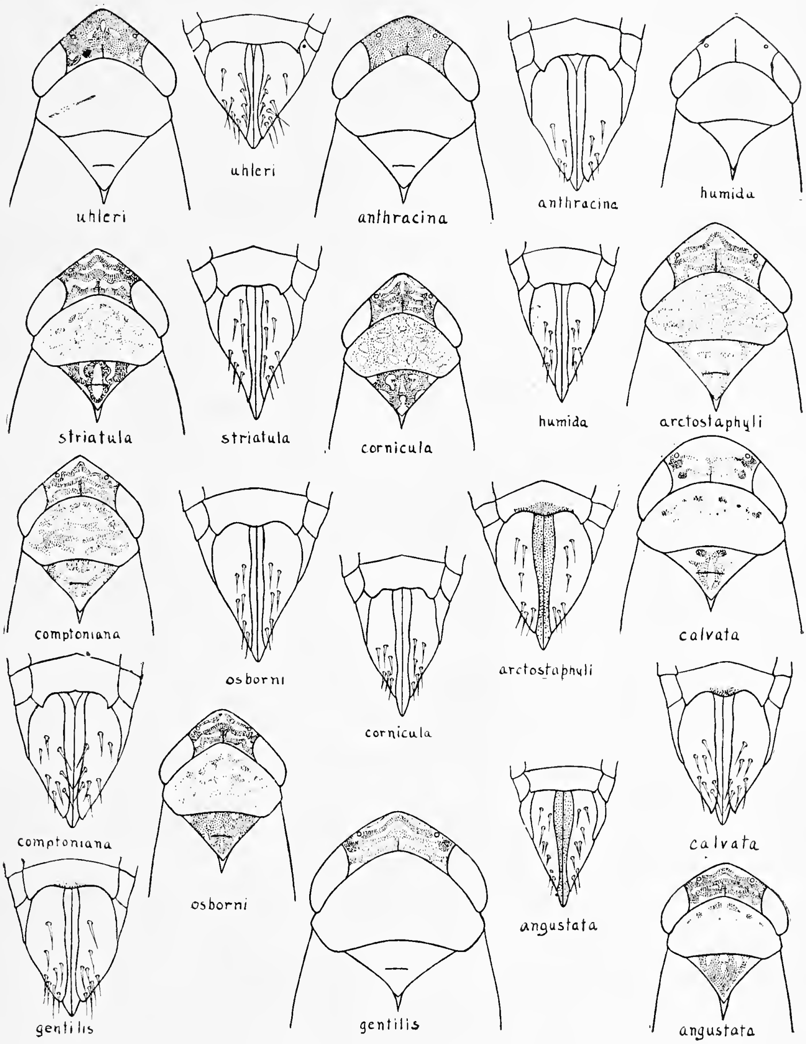
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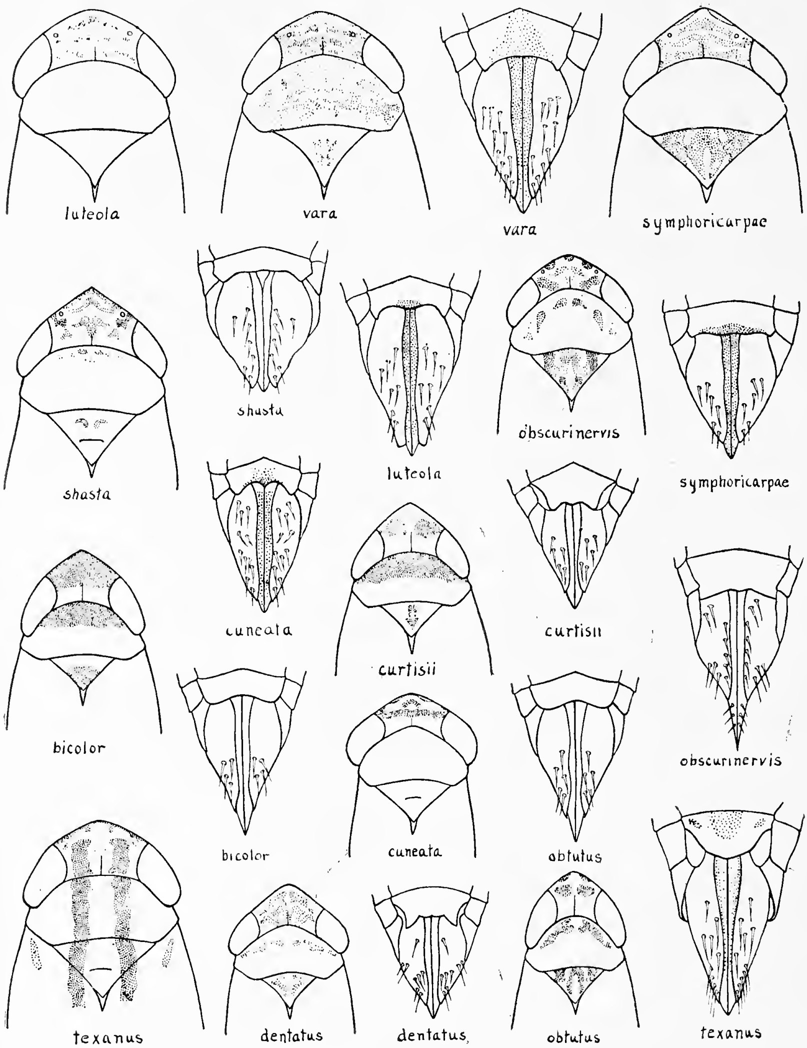
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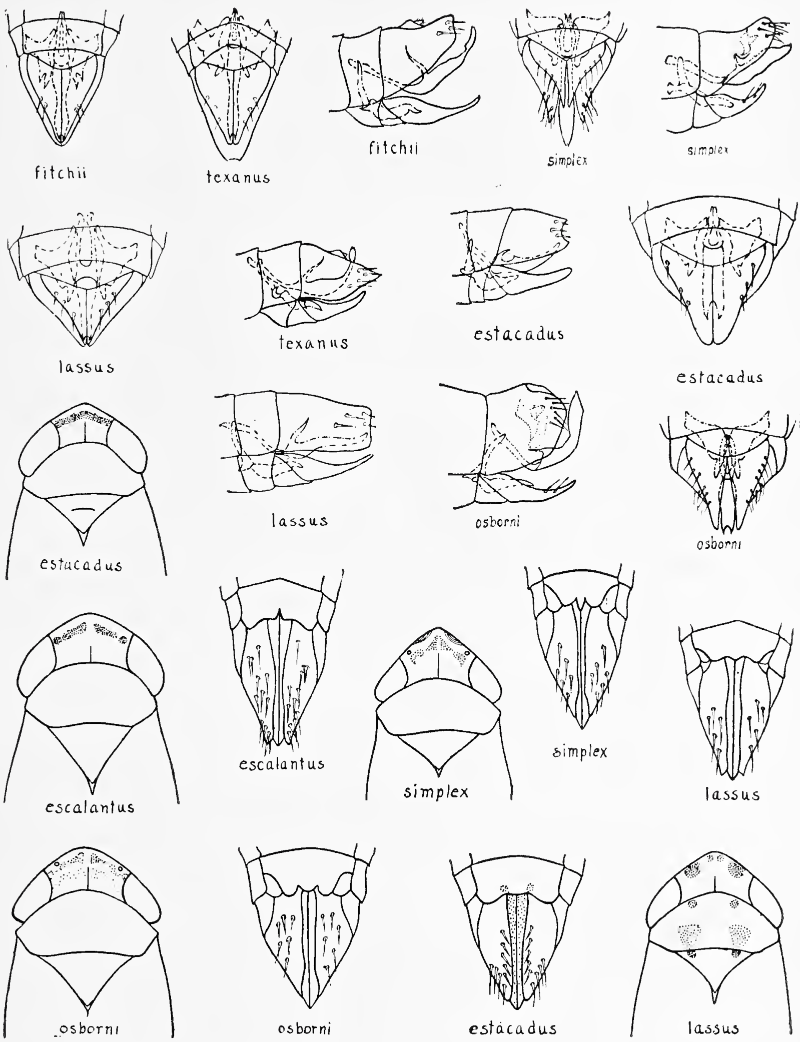
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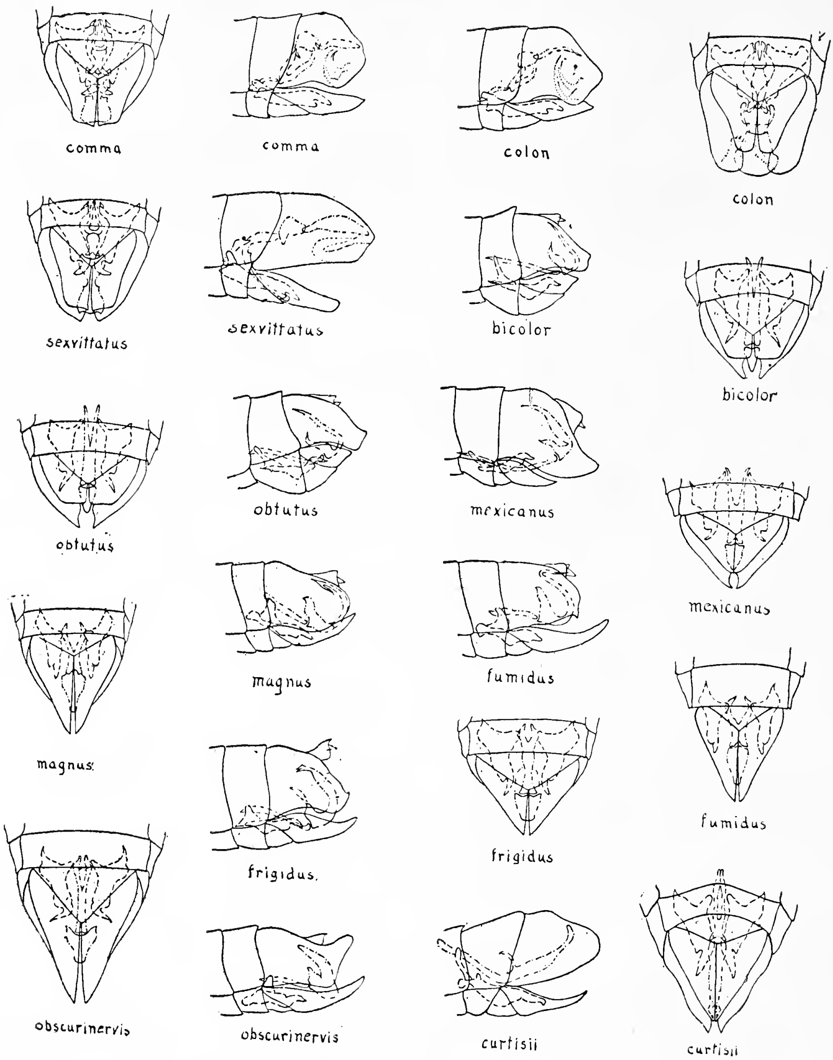
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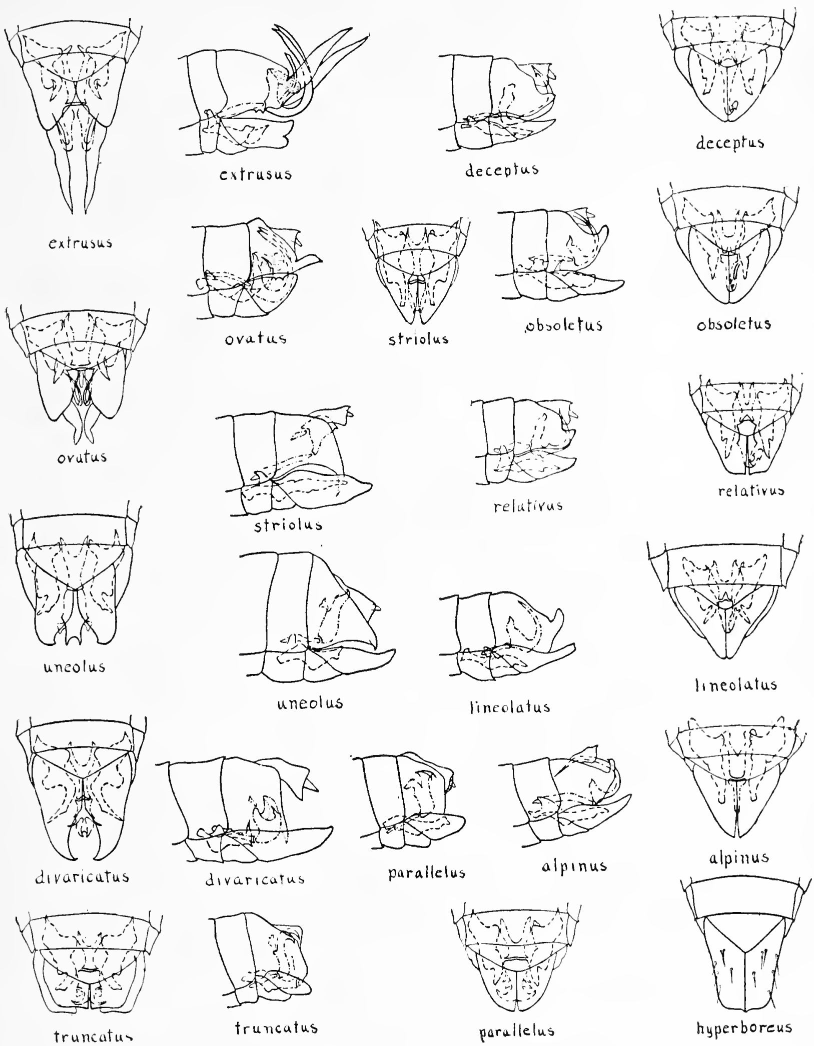
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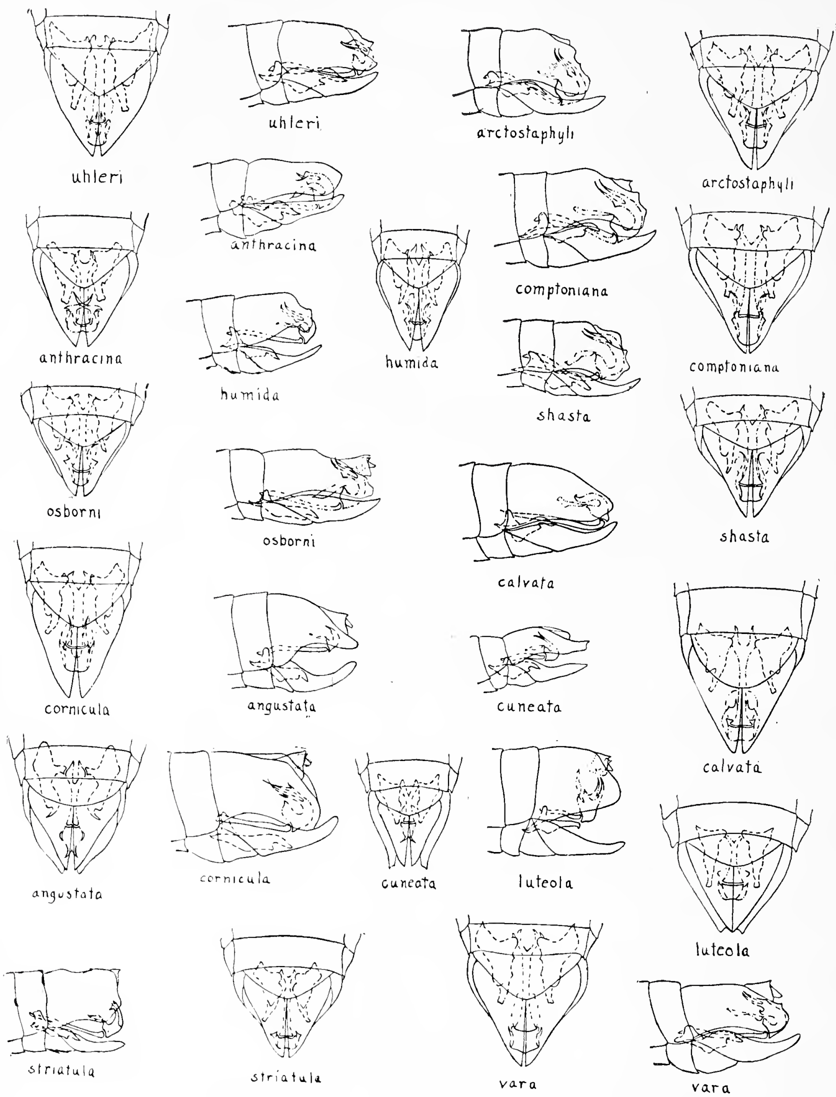
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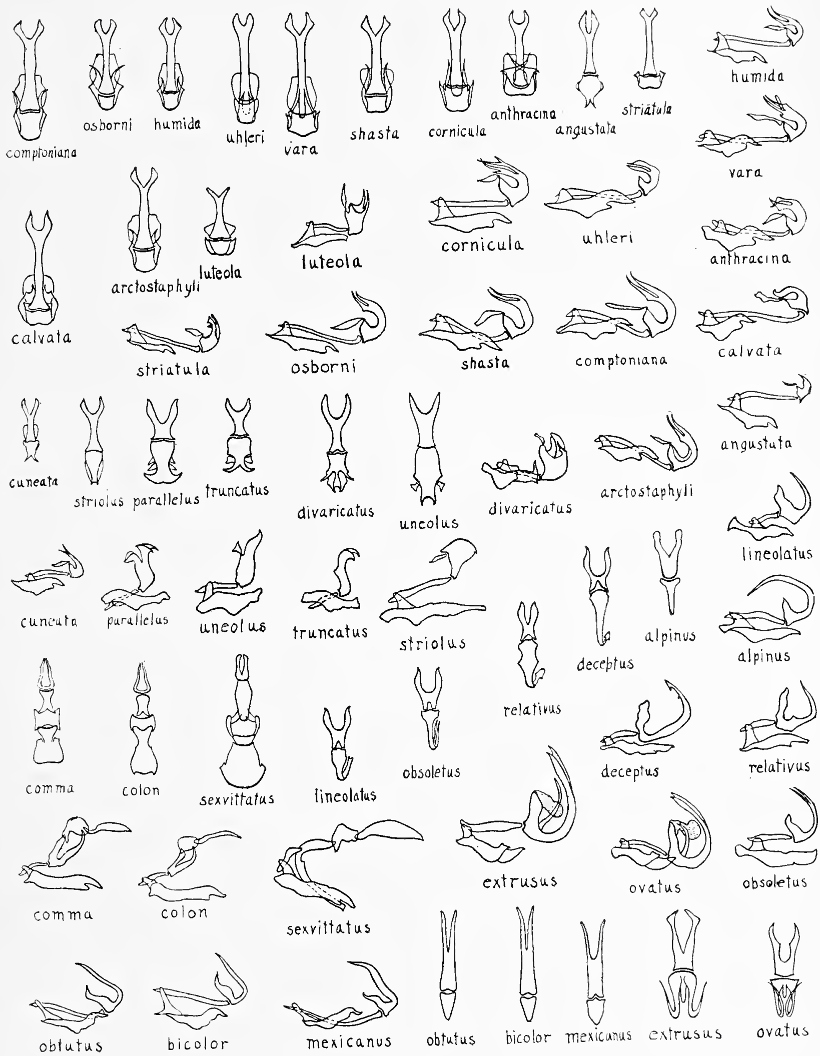
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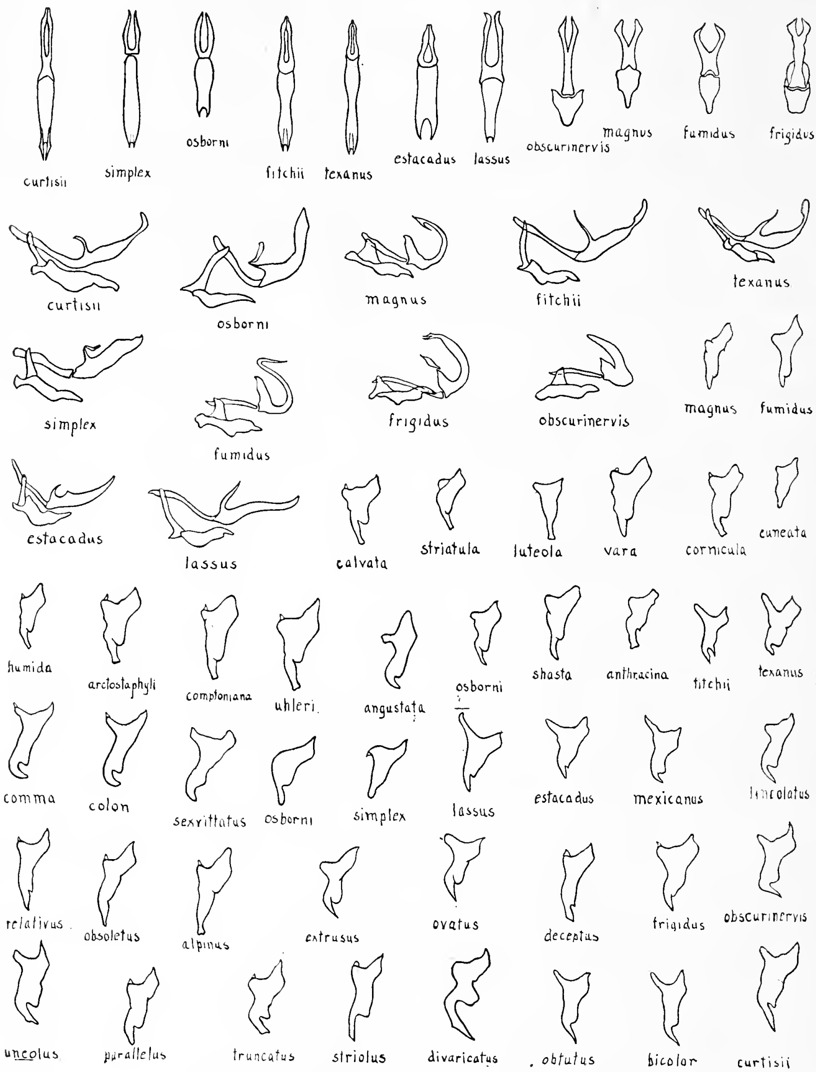
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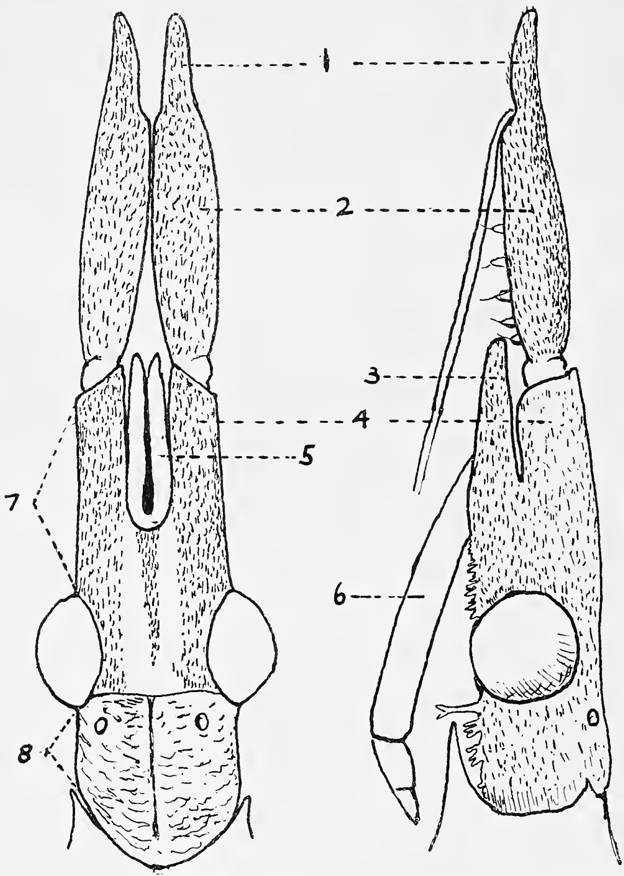
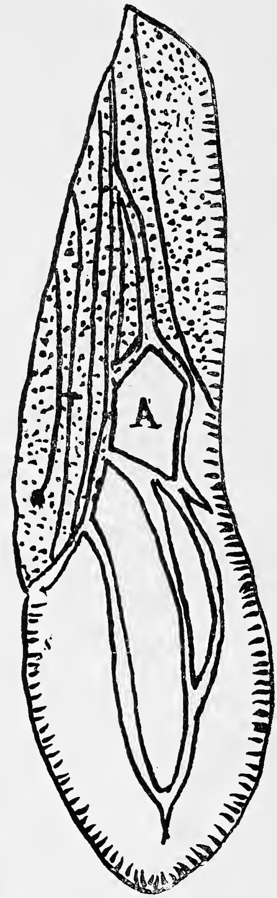


Head of Pnirontis serripes.

1. Apical process.
2. Basal segment of antenna.
3. Gena produced.
4. Antenniferous tubercle.
5. Jugae.
6. Rostrum.
7. Preocular margin.
8. Postocular margin.



Wing of Pygolampis pectoralis.
(After Hemiptera of Connecticut).
A—Pentagonal cell.

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ESSAY ON THE SUBFAMILY STENOPODINAE OF THE NEW WORLD

By H. G. Barber
ROSELLE, N. J.

INTRODUCTION

This treatise is concerned mainly with the Neotropical Stenopodinae but for purpose of comparison I have included the Nearctic genera and species. Up to the present time 17 genera with 50 species have been listed from the above faunal regions. I have added 3 new genera and 28 new species, only two of which occur in the United States. A survey of the known geographical range of the included species demonstrates that this subfamily reaches its maximum development in South America. Only 14 species are here recorded as occurring north of the Mexican border and of these a bare half dozen are found rather uncommonly in the northern states. All of the remainder are Neotropical. The only types I have been able to see were *Rutuba perpugnax* Bueno and *Achillas bicaudatus* Bueno and a paratype of *Seridentus denticulatus* Osborn. For the recognition of the remaining genera and species I have had to depend on the author's original descriptions. I regret that I have not been able to see specimens of *Nitornus lobulatus* Stål, *Podormus granulatus* Stål and either of the described species of *Rhyparoclopius.* I have therefore been forced to omit these in the general discussion but have arranged these genera in the key. Three of Walker's species it has been impossible to recognize as follows: *Ctenotrachelus longicollis, Pnirontis filiformis* and *Stenopoda? hyalinipennis.* Also three of Distant's species are unknown to me: *Pnohirmus whymperi, Stenopoda scutellata* and *Nitornus fuliginosus.*

Due to the courtesy of the curators of several museums mentioned below and to the kindness of individual collectors I have been able to see a large amount of material. Very fine collections were received from the U. S. National Museum, Cornell University, Museum of Comp. Zool. Harvard University, Carnegie Museum. Smaller collections were studied belonging to the American Mus. of Nat. Hist. and Acad. of Nat. Sciences of Phil. Mr. E. P. Van Duzee, J. R. de la Torre Bueno and Dr. S. B. Fracker helped me by the loan of certain species from their collections. My own collection also contributed some records.

The most reliable character for differentiating the Stenopodinae is found in the venation of the hemielytra, which at the apical margin of the corium are provided with a large cell (usually pentagonal) from the posterior margin of which extend two elongate cells of the membrane, the outer one of which extends further caudad. The geniculate character of the antennae with the basal segment more or less elongate and incrassate is also an important subfamily character. For generic diagnostic characters I have depended rather freely upon those employed by Stål modifying them somewhat in order to render them more definite. It will be noticed that I have not had recourse to the character of the genitalia as for the most part this was not necessary in order to differentiate the species.

FAMILY REDUVIIDAE

Sub-family Stenopodinae

Characters:—*Body* depressed. *Corium* furnished with a large, usually 5-angled discal cell from the apex of which extend posteriorly two elongated inclosed membrane cells, the outer one of which extends further caudad. *Head* porrect and most commonly with the *jugae* more or less produced between the antenniferous tubercles, sometimes these are less obvious and with the tylus more produced. *Antennae* geniculate at base of second segment, with the more or less incrassate and elongated basal segment porrect (in cabinet specimens) the remaining segments more slender. *Prosternal* spines commonly porrectly, more or less acutely produced.

KEY TO GENERA OF STENOPODINAE

1. Head ventro-laterally behind eyes armed with ramose or forked spines 2
   Head behind eyes unarmed or provided with simple setigerous spines 7
2. Basal segment of antenna produced in a spine or apical process beyond the insertion of second segment; devoid of a spongy fossa at apex of anterior tibia; these usually furnished with spines more or less evident 3
   Basal segment of antenna not produced beyond the insertion of second segment; anterior tibia always unarmed 4
3. Antenniferous tubercles armed with a distinct nearly erect spine; lateral angles of connexival segments spinously produced; large species ..... *Rutuba* Bueno
   Antenniferous tubercles unarmed or provided with minute spines; lateral angles of connexival segments not produced; small species ..... *Pnirontis* Stål
4. Anterior femora scarcely incrassate, unarmed below; apices of genae not anteriorly produced in a spine or process; basal segment of rostrum almost doubly longer than second and third united; posterior femora elongate ..... *Pygolampis* Germar
   Anterior femora armed with spines below; incrassate (except in *Zilobus*) 5
5. Genae anteriorly produced in a porrect spine at base of rostrum; basal segment of rostrum as long as or but little longer than the last two segments united; head but little if any longer than pronotum; connexivum not expanded; eyes not strongly protruding ..... *Gnathobleda* Stål
   Genae not anteriorly produced in a porrect process at base of rostrum; basal segment of rostrum shorter than the last two united; ocelli strongly elevated; connexivum expanded, somewhat angulate or lobate; eyes strongly protruding 6
6. Head shorter than pronotum; connexival margin of fourth abdominal segment angularly expanded (male); anterior femora strongly incrassate ..... **Kodormus** n. gen.
   Head longer than pronotum; connexival margin with segments 1 to 6 angularly lobate (male); anterior femora slender; corium with two discal cells ..... **Zilobus** n. gen.
7. Head ventro-laterally behind eyes unarmed with setigerous spines 8
   Head behind eyes armed with distinct, simple setigerous spines (rarely so in *Apronius*) 10

8. Jugae extended in two nearly parallel porrect processes well beyond apices of antenniferous tubercles; anterior femora scarcely incrassate .... *Diaditus* Stål

Jugae short, extending but little if any beyond apices of antenniferous tubercles; anterior femora incrassate 9

9. Body narrow; connexival margins entire not expanded; basal segment of antenna long; apex of membrane acuminate. *Pnohirmus* Stål

Body broad; connexival margins expanded, lobate; basal segment of antenna short; apex of membrane not acuminate. *Rhyparoclopius* Stål

10. Pronotum nearly or quite twice as long as head; eyes set about midway on head; ocelli strongly elevated; anterior tibia provided with a spongy fossa at apex 11

Pronotum never twice as long as head, most often but little longer 12

11. Angles of connexival segments ending in spinous foliaceous lobes; apex of membrane rounded; pronotum not quite twice as long as head; angles of pronotum and legs spinose or tuberculate .... *Achillas* Bueno

Angles of connexival segments entire or nearly so; apex of membrane usually acuminate; pronotum usually twice or nearly twice as long as head .... *Ctenotrachelus* Stål

12. Gular region of head with two or more pairs of setigerous tubercles or spines 13

Gular region of head devoid of distinct setigerous spines 14

13. Segments of connexival margin angularly lobate; anterior angles of pronotum long spinose; disk of anterior lobe of pronotum with two erect spines or tubercles. *Ocrioessa* Bergroth

Connexival margin of abdomen entire; anterior angles of pronotum not spinose; disk of anterior lobe of pronotum unarmed; post-ocular margin of head rarely armed with simple spines .... *Apronius* Stål

14. Head, pronotum and legs provided with granules or spines or densely setose 15

Head, pronotum and legs devoid of granules and spines, the latter sparsely setose 18

15. Connexival margin of abdomen expanded, wider than hemielytra; basal segment of antenna much shorter than head 16

Connexival margin of abdomen scarcely expanded but little if any wider than hemielytra; basal segment of antenna longer than head; anterior femora long, lightly incrassate 17

16. First segment of rostrum nearly equal to third and somewhat shorter than second; anterior angles of pronotum devoid of a spine; humeral angles rounded, scarcely prominent; expanded connexival margin entire; anterior femora rather strongly incrassate .... *Podormus* Stål

First segment of rostrum much longer than third and somewhat longer than second; anterior angles of pronotum armed with a spine; humeral angles prominently acute; segments of connexival margin expanded into dentiform acute lobes; anterior femora lightly incrassate.
Nitornus Stål

17. Anterior tibia with an elongate spongy fossa at apex; post-ocular margins of head nearly parallel sided, abruptly contracted before collum .... *Stenopoda* Laporte

Anterior tibia devoid of spongy fossa at apex; post-ocular margins not parallel sided, gently converging behind eyes to collum; disk of anterior lobe of pronotum and lateral margins tuberculate .... **Stenopodessa** n. gen.

18. Pronotum evidently wider than long; apical angles of sixth abdominal segment ending in two angular flaring lobes (male); scutellum armed with an apical nearly erect spine; anterior femora somewhat incrassate; anterior tibia provided with a short spongy fossa at apex; posterior femora short, apices not nearly reaching to apex of abdomen; basal segment of rostrum longer than second..... *Seridentus* Osborn

Pronotum almost equally wide as long; apical angles of sixth abdominal segment not produced, rounded; apex of scutellum horizontally produced; anterior tibia devoid of a spongy fossa; posterior femora long, nearly or quite reaching to apex of abdomen 19

19. Anterior femora scarcely incrassate, unarmed beneath; first and second segments of rostrum subequal........*Narvesus* Stål

Anterior femora incrassate and spined beneath; first segment of rostrum shorter than second ....*Oncocephalus* Klug

Pnirontis Stål 1859[1]

[1] I have not been able to see the following species: *scutellaris* Stål, *pallescens* Stål, *spinimana* Champ., *ståli* Mayr and *filiformis* Walk.

(Type *scutellaris* Stål)

Basal segment of antennae prolonged in an apical process or spine extending beyond the point of insertion of the second segment. Head armed ventro-laterally behind the eyes with a few, either simple or ramose, setigerous spines; antenniferous tubercles porrect, well produced beyond median lobe; jugae commonly produced as two porrect processes or spines between the antenniferous tubercles, sometimes the tylus as a single process is more produced and the jugae undeveloped or much less obvious. Genae lamellarly produced. Anterior angles of pronotum with a short porrect process or spine; humeral angles unarmed. Anterior femora slightly incrassate, these and tibiae armed with a series of more or less elongated spines; the latter without spongy fossa at apex. Anterior trochanter most commonly with a single spine. Small or mediocre species.

Pnirontis subinermis n. sp.

Color cinereous; head and pronotum in part clothed with minute silvery hairs; narrow median line of head and longitudinal groove of pronotum lightly infuscated; inner membranous area of corium and membrane itself sordid white flecked with brown spots; apices of clavus and scutellum as well as posterior marginal vein of discal cell infuscated; incisures of connexival segments of abdomen strongly banded with fuscous; venter, at least anteriorly, provided with a few oval fuscous spots on each side.

Head considerably shorter than pronotum; eyes strongly protruding in the male, much less so in the female; preocular and postocular margins equal, the former equal to length of eye; antenniferous tubercles quite short, outwardly armed with a minute apical spine; jugae slender, acute, slightly divaricate apically, extending a little beyond apex of antenniferous tubercles; ocelli rather small, not elevated; genae very acute, extending for at least half their length beyond the apex of antenniferous tubercles; behind eyes armed with about four short, close-set ramose spines. Basal segment of antenna, including apical spine, a little longer than head (in male type); long pilose within, unarmed below. Apex of basal segment of rostrum extended slightly behind eyes. Pronotum about one-fifth longer than wide, the two lobes nearly equal in length; anterior lobe deeply sulcate posteriorly, continued as a gradually widening deep groove on the posterior lobe; spines at anterior angles short; acute prosternal spines extending forward below the head nearly half way to the eyes. Discal cell of corium much over twice as long as wide. Anterior femora and tibiae armed with very short spines or spinules, much shorter than diameter of these segments of legs; femora within provided with four slightly longer spines and below with a row of fine minute spinules; tibiae before the middle armed with two or three spinules and without any preapical spur or triangular process; anterior trochanters provided with several minute spinules. Lateral margins of sixth abdominal segment gently converging posteriorly and with posterior margin truncate (deformed!). Length 12 mm.

Type: Male; Cabima, Panama, May 17, 1911. Collected by Aug. Busck. (Coll. U. S. N. M.). Paratypes: Male, same date as type, collected May 28, 1911; female, Chapada, Brazil, Nov. Collected by H. H. Smith (Carnegie Museum Acc. No. 2966).

The length of the basal segment of antenna varies in the male for in the paratype this segment is considerably shorter than head. In the female this segment is nearly one third shorter than head and not long pilose within; the eyes are not at all protruding; the antenniferous tubercles furnished with a more obvious spine at apex; fore femora have an inner row of seven small spines and the tibiae with three spines somewhat longer than those of male; lateral margins of the sixth abdominal segment gently converge posteriorly; the genital segment is much narrowed and posteriorly ends in three lobes the middle one of which is slightly incised in the middle. In the male type the sixth abdominal segment is posteriorly truncate; in the paratype this ends in two triangular lobes separated by a deep obtusely angled sinus. Certainly this species and *griseus* which I have described from Bolivia are very closely related and may eventually be found to be the same species. The latter however has the basal segment of antenna spined beneath and the spines of the fore legs are somewhat different.

Pnirontis languida Stål.

Head one fourth shorter than pronotum, the latter a little longer than wide. Eyes not globose but somewhat strongly protruding, their diameter evidently greater than one half of the interocular space. Ocelli large, set closer together in the female than in the male. Antenniferous tubercles short, their inner margin less than half the length of an eye. Basal segment of antenna, including very short apical process, in the male, subequal to length of head and three times as long as preocular margin, densely pilose; in the female only twice as long as preocular margin and nonpilose; in both sexes unarmed below. Jugae short, nearly parallel and scarcely extended beyond apices of the antenniferous tubercles, a little less than one-half the length of the preocular margin of head. Genae often visible from above; seen from the side, subacute at apex and in the male extend one fourth way on basal segment of antenna, in the female nearly half way. Behind eye armed with a single prominent ramose spine followed by a simple spine, with another ramose spine behind this. Anterior femora with an outer row of four rather short spines, spinulose between and an inner row of six shorter spines, those towards base minute. Anterior tibia with only an inner row of rather short spines and with a preapical triangular, compressed process, and no preapical long spur. Corium and connexivum immaculate. Sixth segment of male with margins rather strongly converging posteriorly, with the apices of the two posterior lobes, narrowly, obtusely rounded at apices, the acute sinus between these narrower than a lateral lobe; in the female the first genital segment with the posterior angles very acute, produced to the middle of the last genital segment which has a short acute sinus at apex. Color stramineous-testaceous. Length 13–14 mm.

Records and distribution:—Stål reports this species from Brazil as well as from Carolina, Vera Cruz, Mex.; Cayuga, Guatemala; Panama, and Cayamas, Cuba (U. S. N. M.). My records show that it is less common than *infirma* from the United States.

Pnirontis acuminata n. sp.

Female. Stramineo-testaceous; head dorsally and laterally very lightly infuscated; a broad fuscous stripe runs from the anterior acetabulum through the meso- and metapleura; a faint longitudinal line in the middle of the pronotum and the apex of the membrane infuscated; incisures of the connexival segments very lightly infuscated. Head and pronotum subequal in length, with the latter one fifth longer than wide. Eyes very little protruding much longer than wide; their diameter about equal to one-half of the interocular space; antenniferous tubercles moderately elongate, a little less than the length of an eye, unspined at apex; jugae stout, subparallel throughout, apices blunt, extending beyond the apex of antenniferous tubercles, much shorter than the preocular margin of the head; genae rather obtuse at apex, well extended beyond the apex of the antenniferous tubercles, posteriorly before the eyes provided with several small setigerous spines; behind eyes armed with about four ramose spines; basal margin of head provided with a row of short tubercles. Basal segment of the antenna, including apical spine, about one-half as long as the head but little shorter than the preocular margin, unarmed beneath, apical spine stout, acute, nearly as long as the remainder of the segment. Anterior femora provided with two rows of long curved spines, inner row of eight of which the first three are short and an outer row of four spines annulate with fuscous before base. Anterior tibia with only an inner series of three long spines and a triangular preapical process. Hemielytra much shorter than the abdomen, membrane just surpassing the apical margin of the fifth abdominal segment. Lateral margins of the abdomen converging posteriorly from the third segment; the terminal genital segment extending well beyond the acute lateral lobes of the preceding segment, the sinus between the lobes nearly equally wide as one of the lateral lobes, rounded within. Length 18.5 mm.

Type: Female; Santarem, Brazil, Oct. 1919 (Carnegie Museum. Acc. 6543).

In this species the relative length of the basal segment of the antenna and their unspined character as well as the whole general appearance relate it to *languida*.

Pnirontis inobtrusa n. sp.

Color stramineous; sides of head before and above eyes heavily infuscated; behind eyes, median longitudinal stripe on the pronotum, scutellum except basal angles, clavus more or less, inner half of discal cell of corium, membrane except for the elongate pale discal streaks, longitudinal stripe on the meso- and metapleura continued for a short distance on the sides of venter, lightly infuscated; incisures of connexivum immaculate.

Male. Head and pronotum subequal in length with the latter one-fourth longer than wide. Eyes not strongly protruding, dorsally two and one-half times longer than wide, their diameter equal to one-half the width of the interocular space. Antenniferous tubercles moderately elongate, a little less than length of an eye with a very minute spine outwardly before apex. Basal segment of antenna, including apical spine, one third shorter than head and twice as long as preocular margin to apex of antenniferous tubercles; unarmed beneath, very sparsely long pilose; apical spine stout, subacute, nearly one-third as long as the remainder of the segment; two apical processes (jugae) rather long, as long as an eye, extending well beyond apices of antenniferous tubercles, subparallel; the short stylus visible between these does not reach to their middle point; genae well produced beyond apices of antenniferous tubercles, acute; before eyes armed with several small setigerous spines; behind eyes armed with four or five strong ramose spines. Pronotum subcarinate laterally; anterior lobe strongly, longitudinally sulcate posteriorly. Anterior femora with an outer row of five spines, none longer than diameter of femur, the last one in the series very short; between each of these and between the terminal one and apex are a number of short spinules; an inner series of eight moderately long spines increasing in length towards apex. Anterior tibia with only an inner series of three rather long curved spines and a preapical triangular process. Corium with the discal cell over twice as long as wide. Abdomen with the lateral margins of sixth segment strongly converging posteriorly, ending in two lobes which are lightly rounded at their apices, the sinus between these wide. Length 15 mm.

Type: Male, Prov. del Sara, Bolivia, Dec. 1912. Collected by Steinbach. (Carnegie Museum. Acc. number 5068).

In the series in which the basal segment of the antenna is unarmed this species is closest to *acuminata*. I have suspected that it might possibly be the male of that species but the character of the head, basal segment of antenna, spines of the anterior femora and tibia are so different that I have concluded that it must be distinct.

Pnirontis brevispina n. sp.

Female:—Pale stramineous. Head and pronotum in part finely granulose. Head narrow, the lateral margins fairly parallel throughout, equal to pronotum in length; eyes projecting very little, their diameter about half that of interocular space; seen from the side a trifle longer than wide subtruncate posteriorly; transverse sulcation just behind the middle of line of the eyes, posterior to which is a faint median longitudinal sulcation, reaching the base of head; base of head with three small posteriorly directed spines on either side of the middle point. Ocelli small, relatively closer together than commonly, placed closer to the median longitudinal groove than to the eyes. Antenniferous tubercles (inner margin) extremely short and declined, the prominent acute dorsal spine projecting beyond the apex of these. Basal segment of antenna including apical process very short, a little shorter than preocular margin, the apical spine very short and blunt; unarmed beneath and non-pilose.

The jugae minute, declined not reaching apices of antenniferous tubercles; the tylus produced beyond these in a single acute process which extends somewhat beyond the apices of the antenniferous tubercles. Genae somewhat acute, extending to middle point of basal segment of antenna; finely spinulose along lower edge; behind the eyes armed with a crowded series of eight ramose spines of fairly uniform length. Prosternal spines acute, not reach to middle point of postocular region of head; anterior margin of propleura with three or four short porrect spines. Pronotum one-fourth longer than wide; with anterior lobe not quite twice as long as posterior one; anterior angles furnished with a distinct spine; anterior lobe longitudinally sulcate from before the middle point; the surface smooth with a Y shaped line of small granules either side of the median groove, and an abbreviated line posteriorly, midway between this and lateral margin; posterior lobe somewhat wrinkled; posterior margin before base of scutellum straight. Corium immaculate, with the veins conspicuously pale; discal cell over twice as long as wide. Membrane longitudinally streaked with white, its apex reaching middle of sixth abdominal segment. Fore femora rather more slender than commonly, their apices not reaching far on basal segment of antenna, armed with two rows of fuscous banded long spines, the outer row of four, increasing in length apically, the preapical one very long, spinulose between these; the inner row with four somewhat shorter spines and two or three minute spines towards base. Anterior tibia strongly curved, armed with two rows of spines, an outer row of three rather short spines and a long preapical spur and an inner row of three longer spines. Apical angles of the connexival segments of abdomen very obsoletely embrowned, scarcely fasciate. First genital segment posteriorly parallel sided (dorsally), with posterior apical angles produced into two posteriorly directed, rounded lobes which extend slightly behind the posterior margin of the last genital segment which is very small, quadrate and scarcely incised at apex. Length 14 mm.

Type: Female; Cabima, Panama, May 19, 1911. Collected by August Busck (U. S. N. M.).

This species is considerably longer but most closely related to *brimleyi* in the character of the head and its appendages but may be distinguished from that species by the relatively longer and more decided separation of the two lobes of the pronotum, relatively longer discal cell of the corium and the different character of the genital segment of the females, as well as the immaculate corium.

Pnirontis brimleyi Blatchley 1926.

Described from a single male collected at Raleigh, North Carolina. A single female is in the collection of the U. S. N. M. from Columbus, Texas, from which the following characters are drawn. This species may be readily distinguished from all of the other known species from the U. S. by the following characters:

> The extremely short divaricate lobes of the jugae, with the stout tylus somewhat produced as a single process before these; the short depressed antenniferous tubercles, surmounted by a stout obtuse spine; the short thick basal segment of the antenna, shorter than the pre-ocular margin of head and with a short, thick obtuse process at apex, unarmed below. Genae wide, obtuse extending nearly half way on the basal segment of antennae. Both rows of fore-femoral spines are quite long; the tibia considerably curved and armed outwardly with two smaller spines and a long stout preapical spur, inwardly with three long spines. First genital segment of the female with the outer apical lobes subacute extended nearly to the posterior margin of the last genital segment which is nearly quadrate and shallowly concave at apex. Corium marked with a distinct fuscous spot at inner apical angle of the discal cell and the connexival segments are infuscated at incisures.

This species is not related to any hitherto described species but its affinity to *brevispina* n. sp. from Panama is quite close.

Pnirontis scorpionia Berg 1879.

> Female: Head somewhat shorter than pronotum, the latter about one-eighth longer than wide. Eyes little protruding their width about half of interocular space; seen from the side longer than wide. Ocelli large, set much closer to eyes than to the longitudinal median groove. Antenniferous tubercles short, their inner margin about one-half the length of an eye, scarcely spined at outer apex. Basal segment of antenna (including apical spine) long, nearly one-fourth longer than head, and four times as long as preocular margin of head, not long pilose; armed beneath with 5–6 short setigerous spines towards base; apical process long, stout and acute, about one-fourth as long as remainder of segment. Jugae very short, scarcely visible; tylus extended as a long process, for nearly one-half its length beyond the apices of the antenniferous tubercles, forked at apex. Genae long subacute, well extended beyond apices of antenniferous

tubercles with two or three branched spines before eyes. Behind eyes armed with four or five ramose spines, one next the eye the longest. Anterior femora with two rows of spines, the outer series with three longer spines and an inner series of 6–7 smaller spines with one or two minute basal spines. Anterior tibia with two rows of spines, outwardly with two shorter spines and a stout preapical spur; inwardly with three longer spines. Corium and connexivum immaculate. Genital segments of the female narrowly attenuated; the last genital deeply cleft, with the two lateral lobes narrow, and acuminate, with apices subacute. Color pale testaceous. Length 13 mm.

Records and distribution: Described by Berg from Province of Buenos Aires. San Cristobal, St. Fé, Argentina, Feb. 19, 1920 (Cornell Univ.); Chapada, Brazil (Carnegie Mus. Acc. no. 2966).

This species is related to *pallescens* and *tabida* from both of which it can be distinguished by its double series of fore tibial spines and immaculate corium.

Pnirontis selecta n. sp.

Male: Color yellow testaceous; head very sparsely, obsoletely granulose; vein at inner apical angle of discal cell infuscated; head dorsally between the eyes smudged with fuscous, a slight longitudinal median streak on disk of anterior lobe of pronotum and a broad streak on the meso- and metapleura fuscous; incisures of connexival segments obsoletely infuscated; ventral segments 2–5 of the abdomen with two or three short depressed fuscous fasciae on each side. Head but slightly shorter than the pronotum. Eyes neither globose nor strongly projecting, twice as long as wide, more than half the width of the interocular space; seen from the side much longer than wide. Vertex shallowly, longitudinally sulcate between the eyes before the transverse sulcation. Ocelli set far apart, close to the eyes. Antenniferous tubercles (inner margin) short, less than one-third the length of an eye; unarmed at apex; the preocular margin to base of antenna about equal to length of eye. Basal segment of antenna including short apical spine, only a very little longer than head and over three times as long as preocular margin to base of antenna, profusely long pilose within and armed below with 7–8 distinct setigerous spines, one or two of which are branched. The two apical processes (jugae) short contiguous throughout, scarcely at all extended beyond apices of antenniferous tubercles, and their length about equal to one-half that of the preocular margin of head. Genae very acute, extended about one-fifth way on basal segment of antenna, scarcely spinose below. Behind eyes armed with two or three simple spines, anterior one the most prominent. Prosternal spines long, acute, their apices almost in contact with post-ocular spine. Pronotum one-fourth longer than wide, with anterior lobe one-fourth longer than posterior one and deeply longitudinally sulcate posteriorly; anterior angles with a short subacute spine. Anterior femur with an outer row of five spines, these progressively elongated from base to preapical one, spinulose between these; an inner row of six moderately long spines, this series gradually increasing in length towards apex. Anterior tibia with an outer row of two very short spines and a longer stout preapical spur; with an inner row of three longer spines, with the longest one towards base. Posterior tibia sparsely short setose; posterior tarsus with basal segment very short, the apical one as long as the other two united. Membrane lightly embrowned with apex not reaching middle point of sixth abdominal segment; the latter long and rather strongly contracted posteriorly, nearly one-fourth longer than its basal width, the posterior angles or lobes narrowly rounded at apices and the deep acute sinus between much narrower than a lateral lobe. Length $11\frac{1}{2}$ mm.

Type: Male, Corumba, Matto Grosso, Brazil—Dec. 14–23, 1919 (Cornell Univ.).

This species differs from *infirma*, among other characters in the shorter antenniferous tubercles and jugae, the longer basal segment of antenna and the presence of the preapical spur on the fore tibia.

Pnirontis similis n. sp.

Female: Color testaceous with a median longitudinal fuscous stripe running from base of head through the pronotum; central area of scutellum, a longitudinal stripe from anterior coxae along the meso- and meta-pleura and the venter laterally, fuscous; exposed part of the abdomen with a narrow, median, longitudinal fuscous stripe; incisures of the connexivum immaculate.

Head one-fourth shorter than pronotum; preocular one-fifth longer than post-ocular margin; inner margin of antenniferous tubercles a little shorter than eye; jugae long, parallel, well extended beyond apex of antenniferous tubercles; genae long, acute, extended well beyond apex of antenniferous tubercles; behind eyes armed with one large ramose setigerous spine and several smaller simple ones. Basal segment of antenna a little longer than head, with a long, stout apical blunt spine and a small apical spine within; armed below with 12–13 simple setigerous spines. Pronotum one-fourth longer than wide with the spines at anterior angles quite acute. Veins of corium conspicuously pale; discal cell much over twice as long as wide. Fore femora armed with an inner row of six long spines increasing in length towards apex and an outer row of four long spines and two much smaller ones towards apex. Fore tibia lightly curved, armed with an inner row of three long spines and outwardly with two longer spines; without a preapical spur but with a small triangular process. Abdomen posteriorly attenuated. Length 17 mm.

Type: Female, Prov. del Sara, Bolivia (Acc. number 5068 Carnegie Museum).

This species is closely related to *inobtrusa* in appearance but differs in the armed basal segment of the antenna and in the character of the spines of the fore femora and tibiae.

Pnirontis granulosa n. sp.

Male:—Head and pronotum distinctly granulose, the latter in a definite pattern. Color pale grayish-yellow, with a prominent black spot at inner apical angle of the discal cell and at apical angles of connexival segments 1–5. Corium and membrane very faintly irrorate with brown; meso- and meta-pleura and the venter longitudinally, on either side of the middle line, marked with a broad fuscous stripe.

Head and pronotum of equal length. Eyes strongly protruding, a little wider than interocular space, seen from the side almost circular in outline. Head distinctly, longitudinally sulcate from just before the transverse sulcation to base. Ocelli large, removed from the eyes by a space about equal to their diameter. Antenniferous tubercles (inner margin) rather long, about equal to the length of an eye, with a minute spine at outer apical angle. Basal segment of antenna relatively short, half as long as head and one-fourth longer than preocular margin, with a very short blunt apical process; sparsely long pilose within; armed below with 5 or 6 small setigerous spines in the central region; apex of second segment of antenna reaching just beyond middle point of eye; third segment very short;

fourth segment about five times as long as fourth. The jugae short, slender, lightly separated towards base, their apices not reaching apex of antenniferous tubercles, and about half as long as preocular margin of head. Genae visible from above, as seen from the side they are rather obtuse at apex which extends very slightly beyond the apex of antenniferous tubercles, slightly crenulate below before the eyes. Behind the eyes with a long branched spine followed by several minute spines and a single branched spine posteriorly. Rostrum with the apex of basal segment reaching midway between eye and base of head. Pronotum nearly one-fourth longer than wide; lateral margins subimpressed; anterior angles armed with acute spine-like process; anterior margin somewhat depressed; anterior lobe smooth with four rows of granules, the one on either side of the longitudinal sulcation forked anteriorly; posteriorly on either side of the longitudinal sulcation with a low, transverse tubercle; posterior lobe just over half as long as anterior lobe, somewhat rugose latterly and furnished anteriorly with four obtuse carinations, evanescent posteriorly, rather strongly depressed in the middle and laterally within the humeral angles. Scutellum sparsely, finely granulose, faintly sulcate in the middle at base. Veins of corium conspicuously pale, and surface faintly irrorate with brown; a very distinct black spot at the inner apical angle of discal cell. Membrane with apex about reaching to middle of sixth abdominal segment, very faintly embrowned and longitudinally pale streaked. Fore femora granulose, moderately incrassate; their apices reaching nearly to the apex of the basal segment of antennae; armed below with two rows of fuscous banded spines, the outer series with four spines, these progressively elongated toward apex, spinulose between these; the inner series with five or six spines, the two nearest base minute. Anterior tibia somewhat curved and likewise armed with two series of long spines banded with fuscous; the outer series consisting of three spines and a long stout preapical spur; the inner series of three longer spines. Connexival segments 1–5 before incisures with a conspicuous black spot. Venter of abdomen with a central longitudinal keel from base to apex of fifth segment, the surface granulose; an oval depressed area on each segment anteriorly midway between middle line and lateral margin. The sixth abdominal segment, seen dorsally, with its lateral margins somewhat converging posteriorly and one-third way from apex suddenly flaring to end in two obtusely rounded lobes, the inner margins of which are not straight; the sinus between obtuse and much wider posteriorly than one of the lateral lobes; genital segment slightly visible from above. Length 13.5 mm.

Type, Male: Paradise Key, Florida, Feb. 24, 1919. Collected by H. S. Barber (U. S. N. M.).

Readily separated from *infirma* by the two rows of tibial spines and shorter basal segment of antenna; from *languida* by the spinous basal segment of antenna; from *brimleyi* by the longer basal segment of antenna and the character of the jugae; from *modesta* by the shorter jugae and the granular character of dorsal parts.

Pnirontis serripes Fab.

Female: Head and pronotum equally long, the latter only slightly longer than wide. Eyes little protruding, not at all globose, the width about one-half the diameter of the interocular space. Ocelli small, set close to eyes. Antenniferous tubercles long, their inner margin decidedly longer than an eye. Basal segment of antenna, including apical process, rather short, only a little more than half as long as head and scarcely one-fourth longer than preocular margins to base of antenna; scarcely if at all pilose; armed beneath with five or six small setigerous spines which are much shorter than diameter of the segment. Jugae long, parallel, contiguous throughout, extending but slightly beyond apices of antenniferous tubercles, one-third shorter than preocular margins of head. Genae subacute at apex, extending slightly beyond apex of antenniferous tubercles. Behind eye armed with two or three ramose spines, the anterior one the most prominent. Anterior femora with an outer row of four long fuscous banded spines, spinulose between these and an outer row of four shorter spines. Anterior tibia outwardly with two small premedian spines and a long preapical spur, inwardly with three long spines, the prebasal one the longest. Corium and connexivum immaculate. First genital segment (female) a little longer than wide; second genital segment a little shorter than first, narrow, obtusely rounded at apex. Length 11–12 mm.

Records and distribution:—Described from Guiana; Canal Zone, Panama (U. S. N. M.); Bartica, Brit. Guiana (J. R. T.-B.).

Serripes and *modesta* are rather closely related but the latter has the connexival segments of abdomen maculate with fuscous.

Pnirontis modesta Banks.

Color pale testaceous; incisures of connexival segments of abdomen marked with fuscous. Head and pronotum subequally long, the latter a little longer than wide; eyes very little protruding; preocular nearly one third longer than the post-ocular margin; behind eyes armed with three or four small ramose spines; antenniferous tubercles rather long, about equalling the length of eye, armed with a small apical spine outwardly; jugae long, exceeding somewhat the apex of antenniferous tubercles; genae obtusely rounded at apex extending but little beyond apex of antenniferous tubercles. Basal segment of antenna one-half as long as head; armed beneath with a few small spines. Anterior femora armed with two rows of four long spines in each row which increase in length towards apex. Anterior tibia with three long spines in the inner row and outwardly with a premedian small spine and a preapical long spur. Male genital segment ending in two short triangular lobes with the sinus between nearly equally wide as one of the lateral lobes; lateral margins of this segment more nearly parallel than in *infirma*. Length 11–13 mm.

Distribution: From Virginia south to Florida and west to Texas; Indiana (Van Duzee).

Pnirontis tabida Stål.

Female: Head nearly one-fifth shorter than pronotum, the latter about one-sixth longer than wide. Eyes very little protruding, a little narrower than half the diameter of the interocular space. Ocelli large, set closer to eyes than to longitudinal median groove. Antenniferous tubercles, short and wide, their inner margin about one-half as long as an eye; scarcely spined at the outer apex. Basal segment of antenna long, including apical process about one-fifth longer than head and over four times as long as preocular margin of head to base of antenna; apical process long, stout over one-fourth as long as remainder of segment; not long pilose; armed beneath with 5–7 setigerous spines towards base from middle and two others nearer apex, none of these in regular alignment. Jugae extremely short not reaching much beyond middle point of antenniferous tubercles; tylus well developed, extending as a long rather stout process for half its length beyond apices of antenniferous tubercles. Genae wide, with apex subacute or narrowly rounded and extended considerably beyond apices of antenniferous tubercles. Head below, behind eyes with several ramose spines, the one next the eye most prominent. Anterior femora with two rows of spines, an outer series of four moderately long spines and an inner series of five or six smaller ones. Anterior tibia with only an inner series of three moderately long spines and below near apex with a short spur. Corium and connexival segments immaculate. Genital segments of the female as in *scorpionia*, much attenuated; the last genital segment is deeply cleft three-fourths way to base, the two outer lobes narrow, acuminate, contiguous throughout. Color stramineous as in *scorpionia*. Length 15 mm.

Records and distribution: Stål described the female from Brazil. Two females, Igarapé Assú, Brazil (J. R. T.-B.).

This may be distinguished from *scorpionia* by the single series of fore tibial spines and from *pallescens* by the immaculate corium and difference in the last genital segment of female as well as the difference in relative length of basal antennal segment.

Pnirontis elongata n. sp.

Male: Color pale testaceous with outer coriaceous part of corium and inner veins rosy-red; a fuscous streak laterally before the eyes and about the ocelli, as well as on the disk of the scutellum and a median longitudinal one on dorsum of abdomen; connexival segments with a fuscous spot at the incisures, concolorous below. Coxae more or less infuscated. Head nearly one-third shorter than pronotum, non-granulose. Eyes strongly projecting, decidedly wider than half of the interocular space; seen from the side longer than vertical width. Ocelli very large, somewhat elevated, set much closer to eyes than to median longitudinal groove. Head rather deeply sunken between the ocelli, followed by a rather shallow almost obsolete median groove to base of head; the transverse groove strongly impressed and strongly arcuate between anterior margins of ocelli reaching the eyes rather close to their posterior margins; antenniferous tubercles short, much shorter than one-half the length of an eye and outwardly armed with a short, acute preapical spine. Basal segment of antenna long, including apical spine, nearly one-third longer than head and nearly seven times as long as preocular margin; apical process very short, blunt and with another smaller acute spine at inner apex; densely long pilose; armed beneath with nine long, setigerous spines, fairly evenly spaced in a row; second segment reaching back to posterior margin of eyes, fourth segment five or six times as long as the very short third segment. The jugae rather long, reaching over one-third their length beyond apices of antenniferous tubercles, subequal in length to preocular margins of head to base of antenna; lightly separated towards base, showing a very short tylus. Genae long, deflected anteriorly, the rounded obtuse apices reaching far beyond apex of antenniferous tubercles and about one-fifth way on basal segment of antenna, roughly tubercular along lower edge. Basal segment of rostrum well extended behind eyes, its apex not reaching middle point of post-ocular region of head. Pronotum non-granulose, one-fourth longer than wide, the anterior lobe over twice as long as posterior one; anterior angles armed with a short acute spine; central disk longitudinally deeply sulcate from well before the middle point; the posterior lobe somewhat wrinkled, scarcely depressed in the center, the longitudinal ridges either side of the middle scarcely elevated, rounded. Membranous part of corium finely wrinkled; apical vein of the discal cell with a slight fuscous mark near outer apical angle. Membrane longitudinally streaked with white, its apex reaching to about the middle of the fifth abdominal segment. Fore femora with a single row of five or six very short setigerous spines below and a few smaller ones within, none of which are as long as the diameter of the femur, spinulose between these. Fore tibia inwardly with two short setigerous spines towards base, neither of which is as long as diameter of tibia and a shorter median spine with no preapical spur. Abdomen elongated, the sixth segment of male, nearly one-third longer than wide, the lateral margins, gradually converging posteriorly to end in two rather short rounded lobes, the sinus between subacute about as wide posteriorly as a single lateral lobe. Length 16 mm.

Type: Male; Lassance, Minas Geraes, Brazil, Nov. 9–19, 1919 (Cornell Univ.); six paratypes, Prov. del Sara, Bolivia, Nov., 1915. Coll. by Steinbach (Carnegie Museum Acc. No. 5068).

This species is quite distinct from any other herein treated but would seem to come in the series with *scutellaris, scorpionia* and *tabida* but is readily distinguished by the character of the jugae and especially by the difference in the armature of the fore femora and tibia. It should be noted that Stål in his original key to the genus *Pnirontis*—Öfv. Vet. Akad. pp. 6–7, 1859, was in error in reference to the statement that the basal segment of the antenna was unspined. This was later corrected by him in the Hemiptera Fabriciana.

Pnirontis grisea n. sp.

Male: Color grayish; incisures of the connexival segments above and below plainly marked with fuscous; venter with a narrow longitudinal fuscous streak either side of middle line.

Head one-sixth shorter than pronotum; eyes strongly protruding, much wider than half of interocular space and somewhat longer than preocular margin; preocular and postocular margins nearly equal; ocelli large; antenniferous tubercles rather short, not much longer than one-half the length of eye; jugae slightly exceeding the apex of antenniferous tubercles; genae long, acute, extending far beyond apex of antenniferous tubercles; behind eyes armed with three strong ramose spines. Basal segment of antenna a little longer than head with a short blunt spine at apex and armed below with 10–12 short, pale setigerous spines. Pronotum but little longer than wide; dorsally with four rather pronounced ridges posteriorly, more pronounced between the lobes, the surface between these rugulose. Anterior femora with an inner row of four or five short setigerous spines not in alignment, below these on the lower surface are two rows of close-set numerous setigerous spinules, four of which are a little longer than the others. Anterior tibia within armed with three very short spines, shorter than diameter of tibia; below with numerous short oblique setae; preapical spur or triangular process missing. Genital segment with lateral margins gradually converging posteriorly and ending in two obtusely rounded lobes; a wide obtuse angled sinus between these. Length 12 mm.

Type: Male, Prov. del Sara, Bolivia; collected by Steinbach. (Carnegie Museum Acc. number 5068).

This has much the general appearance of *subinermis* described from Panama, from which it differs, among other characters, in the presence of spines on basal segment of antenna and the peculiar armature of the anterior femora.

Pnirontis incerta Reuter 1887.

Male: Head one-third shorter than pronotum, the latter one-sixth longer than wide. Eyes rather strongly protruding, their diameter greater than one-half of the interocular space. Antenniferous tubercles rather long, their inner margin considerably shorter than the length of an eye. Basal segment of antenna (including apical spine) one-fourth longer than head, about four times as long as preocular margin to base of antenna, profusely long pilose; armed beneath with 8 or 9 long setigerous spines; apical spine rather long. Jugae long, well extended beyond apices of antenniferous tubercles and but little shorter than preocular margin; the tylus sometimes visible between the bases of jugae. Genae well extended beyond apices of the antenniferous tubercles, rather obtuse at apex. Behind eyes armed with two or three ramose spines, the one next the eye most developed. Anterior tibia armed inwardly with three moderately long spines, and with no long preapical spur. Anterior femora armed with an inner and outer row of four long spines. Corium immaculate. Connexivum with a fuscous spot at each incisure. Sixth abdominal segment of male, apically much as in *infirma*. Female not seen. Color grayish-testaceous. Length 10½ mm.

Records: Pará District, Surinam (Cornell); Prov. del Sara, Bolivia (M. C. Z.); Prov. del Sara, Bolivia (Carnegie Mus.).

Closely related to *infirma* but a little narrower with a longer basal segment of antennae and genae more produced. Reuter described this species from a male specimen labeled "India" from the collection of Signoret, certainly an error as to locality. I have not seen the type of this species but the specimens before me answer so well to the author's description I have little doubt of the accuracy of my determination.

Pnirontis edentula Berg.

Female: Head and pronotum subequally long, the latter very little longer than wide. Eyes moderately protruding, seen from the side, circular in outline. Ocelli set midway between median longitudinal groove and eye. Antenniferous tubercles rather long (inner margin), nearly one-fourth longer than eyes, not noticeably spined at apex. Basal segment of antenna (including apical spine) but little shorter than head, about twice as long as preocular margin to base of antenna; apical spine over one-third as long as remainder of segment; armed beneath with six short setigerous spines. Jugae long, nearly as long as preocular margins of head, nearly parallel, very slightly separated basally. Genae narrow, acuminate, extended but very little beyond apices of antenniferous tubercles, spinulose below towards base. Behind eyes armed with two branched spines with a smaller simple one between these. Anterior femora armed below with two rows of spines, outer row of 4 moderately long spines, spinulose between these and an inner row of 5 or 6 somewhat shorter spines, with one or two minute basal spines. Anterior tibia with only an inner series of three moderately long spines and no preapical long spur but provided with a triangular compressed tubercle before apex below. Corium with a slight fuscous spot on the apical vein of the discal cell. Connexival segments with a fuscous spot at incisures. First genital segment of the female with the posterior lateral angles (dorsal view) drawn out into narrowly attenuated, acute processes which reach well beyond the middle point of the last genital segment which is much longer than wide and deeply incised posteriorly; the lobes on each side of this acute at apices, and contiguous. Color grayish-testaceous. Female: Length 12–13 mm.

Records and distribution: Described from Buenos Aires by Berg; Corumbá, Matto Grosso, Brazil (Author's collection); Rurrenabaque, Bolivia. Coll. by W. M. Mann (U. S. N. M.).

Pnirontis infirma Stål 1859[1]

Head shorter than pronotum with the latter equally wide as long. Eyes moderately protruding, about as wide as one-half the diameter of interocular space. Antenniferous tubercles rather long, their inner margin scarcely longer than an eye. Basal segment of antennae (including apical spine) about two-sevenths shorter than head, nearly twice as long as preocular margin; sparsely pilose, armed beneath with 6–7 small setigerous spines and on inner side with three spines (male), apical spine moderately long, one-fourth to one-fifth as long as remainder of segment. Jugae long, well extended beyond apices of antenniferous tubercles and nearly or quite as long as preocular margin of head. Genae rather obtuse at apices which are scarcely extended beyond the apex of antenniferous tubercles. Behind eye armed with a prominent ramose spine followed by one or two smaller simple or ramose spines. Anterior femora armed below with an outer row of four and an inner row of five or six moderately long spines, the inner series usually the longest, but the spines of neither series longer than the diameter of femur. The fore tibia with only an inner series of three long spines and no elongated preapical spur. Corium immaculate. Connexival segments marked with fuscous at each incisure. Apical lobes of the sixth segment in the male

[1] Mayr gives the opinion that *spinossima* Kolenati erroneously described from the Caucasus is probably a synonym of *infirma* Stål.

rounded, the sinus between acute. In the female the first genital segment (seen dorsally) with the lateral lobes subacute, their apices not reaching much beyond middle of last genital segment which is acutely incised in the middle. Cinereous-gray. Size 10–10½ mm.

Distribution—U. S. through Mexico, Central America to Brazil; Jamaica and Cuba.

Records: Panama; Honduras; No. Brazil; Georgetown, Brit. Guiana, Cuba (U. S. N. M.). Canal Zone, Panama and Jamaica (M. C. Z.). Igarapé Assú, Brazil (J. R. T.-B.). Pirapora and Lassance, Minas Geraes; Corumbá, Matto Grosso, Brazil (Cornell Univ.); Prov. del Sara, Bolivia (Carnegie Museum).

Key to Genus Pnirontis

1. Basal segment of antennae unarmed beneath 2
   Basal segment of antennae armed beneath with a row of spines 7
2. Fore tibia with only an inner series of spines 3
   Fore tibia armed with two series of spines and with a long preapical spur; tylus produced as a single process beyond the very short jugae; antenniferous tubercles armed with a stout spine 6
3. Anterior femora below armed with an outer series of very numerous minute spinules and an inner series of very small spines; anterior tibia within armed with three very short spines; without a preapical spur or triangular process; basal segment of antennae nearly or quite as long as head; antenniferous tubercles with a small spine before apex; connexivum banded with fuscous .... **subinermis** n. sp.
   Anterior femora armed with two series of spines some of which are either nearly as long or much longer than the diameter of femur; basal segment of antennae shorter than head; antenniferous tubercles unarmed 4
4. Anterior femora with an outer series of three or four spines, the longest nearly equal to diameter of femur and an inner series of five or six spines shorter than diameter of femur; fore tibia with three rather long spines and a triangular preapical process; connexivum immaculate .... *languida* Stål
   Anterior femora with an inner series of eight and an outer series of four or five spines; anterior tibia with three spines; head and pronotum equally long 5

5. Spines of fore femora rather long, some two or three times as long as diameter of femur; spines of fore tibia long; connexivum lightly marked with fuscous at incisures; basal segment of antennae nearly equal to length of preocular margin of head in female .... **acuminata** n. sp.

Spines of fore femora and tibia scarcely longer than diameter of those parts; connexivum immaculate; basal segment of antennae nearly twice as long as preocular margin of head in male .... **inobtrusa** n. sp.

6. Anterior coxae armed with a distinct, anteriorly directed spine; head below provided with eight or nine close set ramose spines behind the eyes; narrow species with pronotum one-fourth longer than wide; corium and venter immaculate; connexival incisures obsoletely infuscated. Female .... **brevispina** n. sp.

Anterior coxae unarmed; margin of head behind eyes provided with 3 or 4 irregular ramose spines; pronotum nearly as wide as long; discal cell with a fuscous spot; connexival segments distinctly marked with fuscous; venter with a row of orbicular spots either side of middle. Female .... *brimleyi* Blatch.

7. Fore tibia armed with two series of spines 8

Fore tibia armed only with an inner series of spines 13

8. Head with tylus produced in a single process; jugae minute; basal segment of antenna considerably longer than head; genae well extended beyond apex of antenniferous tubercles; anterior trochanters armed with a spine; anterior femora with an inner series of 7–8 and an outer series of 4 spines; corium and connexivum immaculate. Female .... *scorpionia* Berg.

Head with jugae well produced anteriorly as two processes; tylus minute or invisible 9

9. Basal segment of antenna with apical process as long or a little longer than head, about three times as long as preocular margin; apex of genae reaching far beyond apex of antenniferous tubercles; eyes not strongly protruding 10

Basal segment of antenna including apical process not much more than half the length of head, but little longer than preocular margin; apex of genae extending but little beyond apex of antenniferous tubercles; anterior tibia strongly curved 11

10. Basal segment of antenna with a slender apical spine; distinctly pilose within; jugae very short, not exceeding apex of antenniferous tubercles; preocular margin of head not longer than eye; anterior tibia with a long, stout preapical spur .... **selecta** n. sp.

Basal segment of antenna ending in a stout apical spine; not long pilose; jugae rather long, exceeding the apex of antenniferous tubercles; preocular margin of head evidently longer than eye; anterior tibia with a preapical triangular process within.......... **similis** n. sp.

11. Jugae short, not extending as far as apex of antenniferous tubercles; basal segment of antenna with a very short, blunt apical spine; sparsely long pilose within; eyes rather strongly protruding; head and pronotum finely granulate; corium with apex of discal cell and incisures of connexivum distinctly marked with fuscous. Male.......... **granulosa** n. sp.

Jugae longer, extending somewhat beyond apex of antenniferous tubercles; basal segment of antenna not long pilose, ending in a longer, more acute spine; eyes not strongly protruding; corium immaculate or nearly so.......... 12

12. Connexival segments of abdomen immaculate; lateral margin of pronotum strongly impressed, carinate; prothorax and hemielytra lightly embrowned with the margins paler.......... *serripes* Fab.

Connexival segments marked with fuscous at the incisures; lateral margins of pronotum scarcely carinate.......... *modesta* Banks

13. Tylus extending in a single stout process beyond apex of antenniferous tubercles; jugae very short, scarcely visible; basal segment of antenna, including long apical spine one-fourth longer than head; genae short extending but little beyond apex of antenniferous tubercles; anterior tibia with preapical spur; corium and connexivum immaculate. Female.......... *tabida* Stål

Tylus very short with jugae extending as two porrect processes beyond this; connexivum commonly marked with fuscous at incisures.......... 14

14. Genae long, acute, well extended beyond apex of antenniferous tubercles; all spines of fore femora and tibiae shorter than diameter of those segments of legs; fore tibia straight, without preapical spur or triangular process; head distinctly shorter than pronotum.......... 15

Genae relatively short, not at all or scarcely exceeding apex of antenniferous tubercles; some of the spines of fore femora and tibiae longer than diameter of those segments of legs; anterior tibia either straight or curved, armed with a small preapical triangular process within.......... 16

15. Basal segment of antenna decidedly longer than head, bispinose at apex and commonly long pilose within (vari-

able), spines beneath as long as diameter of segment; incisures of connexival segments lightly marked with fuscous. Male .... **elongata** n. sp.

Basal segment of antenna subequally long as head with a very short single spine at apex, very shortly pilose, spines beneath very short; incisures of connexival segments broadly marked with fuscous; general color grayish. Male .... **grisea** n. sp.

16. Basal segment of antenna, including spine, about equal to length of pronotum, equal to or a little shorter than head and much over twice as long as preocular margin; armed with 9 or 10 spines below .... *incerta* Reuter

Basal segment of antenna plainly shorter than length of pronotum and about twice as long as preocular margin of head 17

17. Pronotum plainly longer than wide; antenniferous tubercles long, about one-fourth longer than eye; eyes not much protruding .... *edentula* Berg.

Pronotum about as wide as long; antenniferous tubercles shorter, about equal to length of eye; eyes rather strongly protruding .... *infirma* Stål

Rutuba Bueno

(Type *perpugnax* Bueno)

Related to *Pnirontis.* Head has much the character of that genus with the long basal segment of the antenna produced in a long apical spine beyond the insertion of the second segment; unspined beneath. Antenniferous tubercles are armed with a long, acute, semi-erect spine. Tylus produced as a single acute process before the much reduced jugae. Genae long acute, spined beneath. Behind eyes armed with ramose spines. Fore femora and tibia armed with two rows of spines. Tibia without a spongy fossa at apex. Posterior tarsal segments subequal in length. Pronotum much longer than wide, acutely spinose at anterior angles; lateral margins with an acute tubercle between the two lobes. Discal cell of the corium long. Apical angles of the sixth segment prolonged in acute spine-like processes extended far behind the genital segment, which is somewhat visible from above. Venter longitudinal carinate to apex of fifth segment.

Rutuba perpugnax Bueno

Cinereous brown. Head laterally before and behind the eyes, about the ocelli and basally, a median stripe and two lateral stripes on the posterior lobe, median longitudinal stripe on scutellum, clavus with a longitudinal stripe, a circular spot on the discal cell posteriorly and central dorsal disk of abdomen infuscated. Head much longer than pronotum. Antenniferous tubercles extremely short armed with a preapical acute semi-erect spine. Eyes strongly projecting, much wider than half of interocular space. Ocelli large, set a little closer to eyes than to median longitudinal groove. Tylus produced as a single process beyond the apices of the antenniferous tubercles. Basal segment of antenna, including apical spine, about as long as head, three times as long as preocular margin; densely long pilose within; unarmed below. Genae long acute, produced nearly one-third way on basal segment of antenna, armed with six or seven pronounced spines below. Basal segment of rostrum long, reaching behind posterior margin of eye. Behind eyes armed with five spines, the anterior one slightly branched. Prosternal spines long acute. Pronotum much longer than wide, with anterior lobe not twice as long as posterior one; anterior angles armed with acute spines; two sub-acuate tubercles behind anterior margin; lateral margins finely tuberculate, between the lobes armed with a larger subacute tubercle; the central disk longitudinally sulcate from before the middle point, this prolonged on the posterior disk as a shallow depression bounded on each side by carinae, evanescent posteriorly; between these and lateral margin a short granulated carina abbreviated posteriorly. Scutellum longitudinally depressed through the middle. Anterior femora with an outer row of three short spines and a long preapical spine and an inner row of two spines and a long preapical spine. Anterior tibia armed outwardly with three moderately long spines and inwardly with two longer spines as well as a median spine on the front face, with no preapical spur. Discal cell over twice as long as wide. Length, male, 25 mm.

Tumatumari, Rio Potaro, Brit. Guiana, Apr., 1912 (J. R. T.-Bueno).

Pygolampis Germar

(Type *denticulatus* Germar)

Possessing many of the characteristics of *Pnirontis*; differing chiefly in the following respects: basal segment of antenna not prolonged in an apical spine beyond the insertion of the second segment and unarmed beneath; anterior trochanters, femora and tibiae unarmed beneath; posterior legs longer with posterior femora nearly or quite reaching apex of abdomen; venter not carinate in the middle; jugae short with the tylus produced as a short process between them; head dorsally before the collum armed with two prominent tubercles.

Pygolampis pectoralis Say

Basal segment of antenna subequal to or a little longer than the head. Body broader than in the next species; the eyes smaller and less protruding.

Distribution: United States; Cuba (Stål); Jamaica (Mus. Comp. Zool.).

Pygolampis spurca Stål

Basal segment of antenna decidedly longer than head, sometimes twice as long. Body more slender than *pectoralis* and the eyes larger and more bulging. Posterior angles of of the abdominal segments somewhat produced. Two of the male specimens from Prov. del Sara, Bolivia, are nearly black with paler legs: the two carinae of the posterior lobe of the pronotum sharper and the dorsal aspect of sixth abdominal segment wrinkled—var. **nigra** (Carnegie Museum).

Distribution: Panama (Champion); Surinam (Stål); Bartica, Br. Guiana (J. R. T.-Bueno); Moengo, Dutch Guiana; Mackenzie, Demarara and Tumatumari, Brit. Guiana; El Encanto, Perú; Corumbá, Matto Grosso and Lassance, Minas Geraes, Brazil (Cornell); Upper Mazaruni R., Br. Guiana; Cacaqualito, Colomb; Prov. del Sara, Bolivia; Chapada and Rio Janeiro, Brazil (Carnegie Mus.); Pozo Azul, Costa Rica; Corumbá, Matto Grosso, Brazil (my coll.).

Pygolampis atrolineata n. sp.

Dorsal part of head and a broad stripe before and behind the eyes, pronotum, scutellum, hemielytra except for a pale spot before the middle of the outer discal cell of the membrane, connexivum except for the pale incisures and lateral fascia of the sixth abdominal segment heavily infuscated; a black spot on the vein at the outer apical angle of the discal cell of the corium; basal segment of antenna and all of the femora irregularly marked with fuscous; anterior and intermediate tibiae with a basal, median and apical fuscous band; anterior coxae, meso- and metasternum for the most part fuscous; intermediate and posterior coxae each with a few elongate fuscous spots; venter with a broad fuscous band either side of the median longitudinal groove, coalescing posteriorly, with two similar but narrower bands between these and the margin; spiracles fuscous. Head setulose and piliferous, almost one-third shorter than pronotum; eyes sparsely setulose; ocelli but little further apart than their distance from the eyes; below armed with a ramose spine behind eyes and at base, between which are two simple setigerous spines. Basal segment of antenna over one-third longer than head, measured from apex of anteniferous tubercles to collum; second segment a little longer than first, provided with a few very short, fine hairs much shorter than diameter of the segment; third segment very short, less than one-third as long as terminal one. Rostrum with apex of basal segment reaching just past middle of postocular part of head; second and third segments very short. Prothorax about one-third longer than head, piliferous; anterior lobe slightly longer than posterior one, disk of the latter not sharply bicarinate; humeral angles strongly raised within. Scutellum longer than wide, lightly canaliculate on basal half; apex calloused. Apex of membrane reaching beyond the middle of sixth abdominal segment; inner margin slightly concave; apex forming a slightly rounded obtuse angle (male). Trochanters, femora and tibia setulose, the anterior femora densely so. Venter longitudinally canaliculate on the middle line to apex of the fifth segment. Connexivum with the apical angle of fifth segment rather prominently produced. Lateral margins of the sixth segment slightly converging posteriorly (male), somewhat sinuate, ending posteriorly in two obtusely angled lobes slightly reflexed; the sinus between these forming a broad obtuse angle with the genital segment forming a rounded lobe, visible from above. In the female the apical process of the genital segment (seen from above) is relatively longer than in *spurca*. Length, male, 18 mm.; female, 20 mm.

Type: Male, Puerto Suarez, Bolivia, 150 m., collected by J. Steinbach (Acc. No. 3845 Carnegie Mus.); allotype, same data (Carnegie Mus.).

This species is likely to be confused with dark forms of *spurca*. Besides being considerably larger and more robust as to body and legs, the basal segment of the antenna is relatively shorter and is setulose; the second segment is not provided with long erect hairs; the head is relatively longer and the shape of the sixth abdominal segment of the male and the genital segment of the female is quite different.

Key to Species of Pygolampis

1. Body densely pale sericeous. Basal segment of antennae about one-half as long as head. Anterior femora short, incrassate .... *sericea* Stål

   Body more or less piliferous, not pale sericeous. Basal segment of antennae as long as or longer than head. Anterior femora less strongly incrassate 2

2. Basal segment of antennae but little if any longer than head. Head just behind eyes armed with a large ramose spine followed by one or two smaller ones .... *pectoralis* Say

   Basal segment of antennae much longer than head, often nearly twice as long 3

3. Basal segment of antennae nearly or quite twice as long as head, from apex of antenniferous tubercle to collum; finely pilose. Second segment finely pilose with hairs longer than diameter of the segment. Head behind eyes armed with one ramose spine followed by five simple ones .... *spurca* Stål

   Basal segment of antennae shorter, not twice as long as head, setulose. Second segment very sparsely, finely pilose with hairs shorter than diameter of segment. Head behind eyes armed with a ramose spine, another similar one at base and between these with two simple spines. Larger species .... **atrolineata** n. sp.

Gnathobleda Stål

(Type *fraudulenta* Stål)

Somewhat related to *Pnohirmus*. Head below, behind the eyes armed with several ramose spines and a few smaller ones before eyes; bispinose in front; bituberculate basally. Anterior femora somewhat incrassate and armed below with a series of short spines. Basal segment of antenna shorter than head. Genae extended well beyond antenniferous tubercles. Basal segment of rostrum as long as or but a little longer than second and third segment taken together. Venter of abdomen longitudinally sulcate in the middle.

Gnathobleda litigiosa Stål

= *G. tumidula* Stål.

Body broader than in *fraudulenta*. All femora irrorate with brown and with more or less evident preapical band of the same color; fore and intermediate tibia with a subbasal, median and apical brown band. Connexival segments banded with fuscous.

Records: Mexico and Cuba (Stål). Los Amates, Quata, and vicinity of Havana, Cuba (M. C. Z.). Tapachula, Mex.; Quirigua, Guat., Panama and Cuba (U. S. N. M.).

I agree with Champion that *tumidula* is not distinct from *litigiosa*.

Gnathobleda fraudulenta Stål

Narrower than the preceding. Legs except for apex of posterior femora not irrorate or banded with brown. Connexivum not banded with fuscous.

Records: Surinam (Stål). Panama (Champion). Corumbá, Matto Grosso, and Pirapora, Minas Geraes, Brazil (Cornell). Pará, Brazil (U. S. N. M.).

Pnohirmus Stål

(Type *violentus* Stål)

This genus closely related to *Pygolampis* may be distinguished as follows:

Head unarmed below before or behind the eyes; not longitudinally sulcate posteriorly. Anterior femora slightly incrassate, armed beneath with a row of small spines. Basal segment of rostrum not nearly twice as long as the second and third taken together, more nearly equal or shorter than the apical two united. Venter longitudinally carinate.

Pnohirmus violentus Stål

Head and pronotum scarcely granulose or sericeous, subequally long; basal segment of antenna as long as head. Eyes strongly projecting, one-half as long as preocular margin. Ocelli not elevated, rather large and distinct. Jugae very short obliquely truncate at apex, tylus more projecting and deflexed. Antenniferous tubercles very short, their apices not extending beyond apices of jugae. Basal segment of rostrum but little shorter than second and third taken together. Genae lightly extended beyond apices of antenniferous tubercles. Anterior and posterior angles of pronotum rounded, unarmed. Prosternal spine very short. Inner vein of the elongate discal cell of corium strongly curving inwards, produced. Lateral margins of the sixth abdominal segment in the male strongly converging, the posterior margin broadly rounded posteriorly, with the genital segment visible as a broadly rounded lobe. In the female the genital segment is acutely produced. The female is usually paler in color than the male and somewhat larger. Length, male 14–16; female 18–20 mm.

Tabernilla, Canal Zone, Panama (U. S. N. M.). Moengo, Boven Cattica R., Surinam; Corumbá, Matto Grosso, Pirapora, Minas Geraes, and mouth of Rio Teffe, Rio Solimões, Brazil (Cornell). Igarapé Assú, Brazil (J. R. T.-B.). E. Santo, Bahia, Santarem and Nova Olinda, Rio Purus, Brazil; Prov. del Sara; Puerto Suarez, Lower Mamoré, R. and Sta. Cruz de la Sierra, Bolivia; Concepción, Paraguay (Carnegie Mus.). Rio Pacaya, Peru (Acad. N. Sci. Phil.).

Pnohirmus spinifer Stål

Brachypterous male: Densely sericeous. Head from apex of antenniferous tubercles but little shorter than pronotum. Eyes small but strongly projecting, much less than half as long as preocular margin of head. Ocelli small, set rather close together. Head posteriorly before collum bispinose and laterally before base with an acute spine. Jugae elevated into two rather long, compressed, acute, anteriorly inclined spines; tylus depressed. Antenniferous tubercles outwardly at base armed with a small acute spine. Basal segment of antenna a little shorter than head. Genae acutely produced beyond antenniferous tubercles. Pronotum considerably longer than wide; posterior lobe quite short; anterior angles produced into acute spines, humeral angles armed with a semi-erect, blunt spine; posterior margin before base of scutellum bituberculate. Anterior femora provided with a row of short, black, acute teeth; finely setose between these. Fore tibia straight, unarmed. Hemielytra abbreviated, apex of short membrane reaching middle of first abdominal segment. Spiracles placed just below lateral margin of abdomen, somewhat elevated, as seen from above. Apical angles of fifth segment somewhat prominent; lateral margins of sixth abdominal segment of male, lightly converging posteriorly, with the posterior margin nearly truncate, outer angles rounded; genital segment slightly visible from above as a broadly rounded lobe. Length 17 mm.

Macropterous female: Densely sericeous. Head from apex of antenniferous tubercles considerable shorter than pronotum; transverse stricture straight, deep; eyes small but strongly projecting, one-fourth as long as preocular margin; ocelli rather small, set rather closer to eyes than to each other; base of head dorsally and laterally before the collum with a series of short, erect, stiff setae; anteriorly more prominently bispinose than in the male; tylus concealed from above; antenniferous tubercles outwardly armed as in the male; basal segment of antenna as long as head. Basal segment of rostrum nearly equal to second and third segments together. Pronotum somewhat longer than wide; anterior lobe slightly longer than posterior one; anterior angles obtusely tuberculate outwardly; anterior lobe behind the middle with a prominent tubercle just inside of the lateral margins; posterior lobe with two posteriorly divergent rounded ridges evanescent shortly behind the middle; humeral angles not spinose but tumidly elevated within. Scutellum sulcate at base. Fore femora and tibia as in the male. Discal cell of the corium less elongate than in *violentus* and with the inner vein straight. Apex of membrane reaching back to apical margin of fifth segment. Genital segment very lightly, acutely incised at apex. Length, female 20 mm.

Records: Surinam (Stål); male, Coroico, Bolivia (my coll.); female, Bolivia (M. C. Z.). Stål described the brachypterous male from Surinam in Enum. Hem. II, 122, 1872.

The female in some respects is quite different from the male and might readily be considered a distinct species, where the two sexes were not at hand for comparison.

I have not been able to recognize *P. whymperi* which Distant described from La Mona, Ecuador.

Ctenotrachelus Stål 1868

(Type *macilentus* Stål)

=*Schumannia* Champion, Biol. Cent. Amer. Rhynch. II, 185, 1898. (Type *mexicana*.)

Body narrow, elongate. Head much shorter than pronotum. Two anterior processes (jugae) rather short, somewhat acute; surface of gula, margins before and behind eyes armed with a series of simple setigerous spines; those behind eyes larger; antenniferous tubercles armed with a small spine externally; genae anteriorly produced in an acute spine at base of rostrum; the latter not very strongly incrassate, with basal segment as long or but little longer than the two apical segments together. Eyes sometimes strongly protruding, sparsely setose. Ocelli not at all elevated, usually a little farther apart than each is remote from eyes. Basal segment of antenna most commonly nearly glabrous, shorter than head with second segment considerably longer but not twice as long as basal. Pronotum longer than wide, not laterally constricted, with the anterior lobe much longer than posterior one; anterior angles, anteriorly produced, mutic; the humeral angles not prominent, obtusely rounded; lateral margins either smooth or furnished with a series of small setigerous tubercles or spines. Prosternum without the usual single porrect spine or a much reduced one; the anterior acetabula placed just back of the anterior margin. The anterior coxae longer than wide; the trochanters armed with a few small spines; anterior femora somewhat incrassate, armed beneath with numerous small spinules; anterior tibiae with a spongy fossa at apices. The intermediate legs short; the posterior ones elongate, the apex of femur not nearly reaching apex of abdomen. Scutellum elongate, with a more or less developed tubercle at apex. Membrane subacute or narrowly rounded at apex, not reaching to apex of abdomen. Lateral margins of abdomen nearly parallel to each other; apical angles of the sixth segment more or less produced with a broad sinus between these. Venter at least in part, longitudinally carinate through the middle. Posterior angles of the connexival segments slightly produced.

Ctenotrachelus macilentus Stål

Color cinereo-testaceous. Dorsal part of head longitudinally through the middle and middle region of anterior lobe of pronotum obscurely infuscated; anterior femora and hemielytra faintly mottled with fuscous; with a similar colored spot near the center of the outer discal cell of membrane; a dark stripe down the center of the metasternum continued along the venter and another along the pleura; connexival segments at incisures black.

Head one-half as long as pronotum, with preocular margin to apex of antenniferous tubercles one-half the length of postocular to beginning of collum; the two apical processes (jugae) short, acute, nearly parallel to each other; latero-ventrally in front of and ventrally between eyes armed with minute setigerous spinules; behind eyes with five larger simple setigerous spines. Basal segment of antenna nearly four times as long as preocular margin of head; second segment almost one-fourth longer. Rostrum with basal segment reaching back to middle point of eye, subequal to the two apical ones together. Pronotum twice as long as wide, not laterally constricted; the lateral margins smooth, anteriorly nearly parallel sided to a point before middle thence gradually widened posteriorly; the anterior lobe twice as long as posterior one; the central disk of anterior lobe, longitudinally canaliculate from before the middle; anterior angles anteriorly projected, unarmed; the posterior lobe anteriorly set off by a crescentic groove on either side of the middle point, extending forwards in a smooth lateral line to beyond the middle point of the anterior lobe; central disk of the posterior lobe shallowly depressed longitudinally, leaving a smooth, low, flat ridge on either side; the lateral angles obtusely rounded; posterior margin very slightly rounded. Propleura anteriorly, seen from above, strongly dilated and anteriorly armed with several small spines; anterior acetabula placed at anterior margin. Anterior coxae longer than wide; trochanters armed below with several small spines, apical one longest; anterior femora somewhat incrassate, a little more than twice as wide as the intermediate femora, armed below with numerous small spinules arranged in a double series towards base; anterior tibia a little shorter than femur, setose, provided with a short oval spongy fossa at apex; anterior tarsus with the first and second segments very short, together decidedly shorter than apical segment. Scutellum about twice as long as wide; with a slight tubercle at apex. Clavus of the hemielytra three times as long as scutellum, the outer claval vein spotted with fuscous; discal cell of corium elongate, three times as long as wide. The connexivum narrowly exposed; lateral posterior angles of each segment tipped with a slight black spinule; apical angles of the sixth segment ending in two long, porrect, acute processes, with the sinus between obtusely rounded in the male; these angles less extended in the female and the apical margin of the genital segment between these processes truncate. Venter longitudinally in the middle lightly carinate only at the base of segments. Length of male 16 mm.; female 17 mm.

Distribution: No. Brazil (Stål); Manaos and Teffé. Brazil (coll. by H. S. Parish). These are the specimens listed by Dr. S. B. Fracker in his paper on "Notes on Some Neotropical Reduviidae"—1924 and kindly loaned to me for study. Hyutanahan, Rio Purus, Brazil (Carnegie Mus.).

I have combined Champion's genus *Schumannia* with Stål's genus as I can find no important generic characters to differentiate them. It is somewhat doubtful whether Champion actually saw specimens of *macilentus*. Under this genus I have described several new species, some of which might, as in the case of *elongatus* and *lobatus,* be considered as representing distinct genera; but although they differ considerably in size the structural differences when considered comparatively are only relative.

Ctenotrachelus shermani n. sp.

Schumannia mexicana Torre-Bueno, Ent. News 436, 1907.

Schumannia mexicana Blatchley, Heter. E. No. Amer. 549–, 1926.

Color testaceous-yellow; sides and median line of head and pronotum, scutellum in great part, apical vein of discal cell near inner angle, a small oval spot near center of outer discal cell of membrane, apical annulus of basal segment of rostrum and lateral stripe of pleura more or less infuscated; corium and membrane mottled with fuscous; fore femora flecked with fuscous, intermediate and posterior pairs, especially towards apex, infuscated; fore tibia with small prebasal and median spot and apex fuscous; intermediate tibia with premedian and apical ring, posterior with only the apex fuscous; connexivum with a small black spot at apical angles of 1–5; abdomen dorsally mottled with fuscous with two rows of round black spots laterally, a pair on each segment, a narrow median longitudinal black line and most of genital segment black; venter laterally with faint broken traces of the continuation of the pleural vitta with a small oval black spot on each segment between which and margin is another row of fainter spots. Head a little less than half as long as pronotum; preocular margin to base of antenniferous tubercles almost one-half as long as postocular margin to beginning of collum; ventro-laterally with several minute setigerous tubercles before eyes and four longer ones behind the eyes. Ocelli twice as far apart as each is removed from eyes. (Antennae missing.) Basal segment of rostrum a little shorter than second and third segments united. Pronotum nearly twice as long as head, one-third longer than wide, with anterior lobe not quite twice as long as posterior one; the lateral margins smooth; the anterior lobe deeply sulcate down the middle from the center to a rather deep transverse depression on either side of the middle, separating the two lobes; the posterior lobe nearly smooth, shallowly, longitudinally depressed in the middle.

Dilated propleura or acetabula armed with several spines along the margin; the acute prosternal spines, black, small. Anterior coxae with several small black spines; trochanters with several stronger spines; strongly incrassate fore femora armed below with a row of numerous spinules, diminishing in length towards apex, arranged in a double row towards base; anterior tibia shorter than femur, the oval spongy fossa at apex as long as tarsus; tarsus short with the second and third segments fused into one; intermediate legs short; apex of posterior femora reaching to middle of fifth abdominal segment. Scutellum longer than wide with apex narrowly, bluntly rounded and a little elevated; postscutellum with a small black tubercle. Apex of membrane rounded, obtuse, reaching as far as apical margin of fifth abdominal segment. Lateral margins of abdomen (female) not parallel but gently rounded from base to apex; the connexival margins rather broadly exposed with apical angles of fourth and fifth segments angulated and somewhat prominent; the lateral margins of the sixth segment rather strongly converging from base to apex with the apical angles (female) rounded and but slightly produced beyond the truncated margin of the genital segment; the latter with two or three small spines at each outer apical angle. Length female 14 mm.

Type: Female, Raleigh, No. C., June 28, 1902; coll. by Prof. Franklin Sherman, Jr. (U. S. N. M.).

This is the specimen referred to by Prof. Blatchley as *Schumannia mexicana.* His fig. 132 is of the true *mexicana* reproduced from Champion's fig. in the Biologia; also his description pertains to that species. However it should be pointed out that an error occurs on p. 550, line 1, which should read: the front lobe is much longer than the hind one. *C. shermani* besides being much smaller and differently marked can be readily distinguished from *mexicana* by the smooth margins of the pronotum, character of the scutellum and much less parallel margins of abdomen, etc.

Ctenotrachelus mexicanus Champion 1898

Schumannia mexicana Champion.

Grayish-ochraceous; head with a broad fuscous median stripe in front and disk behind the ocelli to base of collum and the central region of anterior lobe of pronotum infuscated; scutellum black; hemielytra mottled with brown, with a brown streak externally along the inner vein of the discal cell; similar streaks along the inner and posterior vein of the outer discal cell of the membrane, the membrane lightly mottled with brown and with a row of small round fuscous spots along the center of the outer cell; a small black spot at the outer-apical angles of each connexival segment; anterior femora faintly mottled with brown; all femora with a fuscous spot above, some distance before apex; the anterior and intermediate tibiae with the apex and spots near the middle brown; venter laterally with a row of brown spots, the surface elsewhere lightly mottled with fuscous.

Head much as in *C. macilentus* but relatively a little longer, somewhat over half as long as the pronotum, with the preocular margins to apex of antenniferous tubercles a little shorter than the postocular to the collum; the two anterior processes (jugae) more produced anteriorly; the apical spine of the antenniferous tubercles more evident; the pregenal spine at base of rostrum acute; behind eyes armed with three or four well developed setigerous spines and several smaller ones at base of head; basal segment of antenna over twice as long as the preocular margin; second segment not quite twice as long as basal one; third segment a little shorter than fourth. Basal segment of rostrum but little longer than the two apical taken together; second and third segments subequal. Dilated anterior margin of propleura and the rim of the acetabula with several small spines; prosternal spine very small. Anterior trochanter with longer black spines at apex; anterior femora rather strongly incrassate, armed below with a series of minute spines, those nearest base black and arranged in a double series; anterior tibia gently curved and provided with an oval spongy fossa which is much shorter than tarsus; the latter with first and second segments fused into one. Pronotum with lateral margins provided with a row of small setigerous spines; very nearly twice as long as wide, with the anterior lobe over one-third longer than posterior one, which is rugulose and furnished with four low ridges, more evident anteriorly; the median narrow sulcus of the anterior lobe is continued as a gradually widening depression in the middle of posterior lobe. The elongated scutellum with a prominent black tubercle at apex followed by a lower whitish tubercle on the post-scutellum. Apical margin of the membrane sinuate before the acute apex which reaches back to beyond the middle of the sixth abdominal segment. Posterior lateral angles of the connexival segments slightly prominent, the fifth particularly more produced; apical angles of the sixth segment produced into broad flat lobes which are somewhat acute, leaving a broad rounded sinus between; the genital segment slightly visible from above. The second and third pair of legs are rather bristly setose; apex of posterior femur reaches to the apex of the fifth abdominal segment. The metasternum, and the first three segments of the venter longitudinally carinate. Length of male 18 mm.

Distribution: near Vera Cruz, Mexico (Champion); Cabima, Panama, May 21, 1911, coll. by Aug. Busck (U. S. N. M.). Kartabo, Bartica District Br. Guiana, Oct. 1920 (Cornell Univ.). Puerto Suarez, Bolivia, 150 m., coll. by J. Steinbach (Acc. No. 3845 Carnegie Mus.).

Ctenotrachelus minor n. sp.

Color grayish-stramineous: side of head before eyes, central vitta dorsally continued through the pronotum faintly infuscated; scutellum in great part black, with lateral and two short median vittae, sordid stramineous; hemielytra lightly infuscated between the paler veins; membrane mottled with brown with a longitudinal vitta on either side of vein separating two discal cells, an oval fuscous spot near the center of the inner discal cell; apical angles of the connexival segments black; antenna with the inner part of basal segment and the remaining segments brown; fore femora and intermediate one towards apex mottled and the posterior pair longitudinally striated with fuscous; all tibiae infuscated at apex, fore one also with some median spots; pleura with a lateral fuscous vitta, continued as a mottled streak laterally on the venter; the latter with two rows of oval black spots along the sides, arranged three on a segment, two in front and one behind.

Head granulose, only about one-third shorter than pronotum; preocular margin to apex of antenniferous tubercles almost one-third shorter than postocular margin to beginning of collum; apical spine of antenniferous tubercles minute; two anterior processes (jugae), short and somewhat divaricate; preocular spines of lower margin small, but distinct; behind eyes armed with five or six setigerous spines, somewhat irregular as to size and arrangement; base of head laterally and dorsally with a few small spines. Basal segment of antenna three times as long as the preocular margin to apex of antenniferous tubercles; second segment almost one-third longer than basal one. Rostrum with basal segment about equal to the second and third united. Pronotum with lateral margins provided with a row of five setigerous spines directed obliquely backwards; not nearly twice as long as wide; the anterior lobe nearly twice as long as posterior one, and canaliculate down the middle from just behind the middle point, with an elongate smooth area on each side just within the lateral margins; the posterior lobe somewhat granulose and finely pilose, with a longitudinal somewhat depressed area in the middle, gradually widened behind bounded by a slight ridge on each side. Dilated propleura and acetabula armed with small spines along the margin; the prosternal spines small, black and located beneath the head. The fore legs as in *testaceus* but the spinules on trochanters and femur black. The elongated scutellum humped or swollen at apex; the postscutellum with a less elevated whitish tubercle. Hemielytra with the veins appearing rather conspicuous on the brown surface, a black spot on the apical vein near the inner angle of the discal cell; the membrane appearing somewhat streaked with brown and sordid white; the apical margin sinuate before the subacute apex which reaches to the posterior margin of the sixth abdominal segment. Connexival margins narrowly visible posteriorly, the angles of the segments a little prominent, the fifth very acute, the sixth extending posteriorly in two subacute processes, which are about as long as their diameter at base; the sinus between wide and truncate above, the genital segment slightly visible from above. The meso- and metasternum as well as the venter as far as the apex of the fifth segment strongly carinate. Length of male 15 mm.

Type: Male, Georgetown, British Guiana, July, 1921—Coll. by Aug. Busck. Paratype: Male, same data (U. S. N. M.).

This species is much smaller than *testaceus* with the lateral margins of pronotum spined.

Ctenotrachelus testaceus n. sp.

Color testaceous-ochraceous; longitudinal median line of head, forked before the transverse groove, and median vitta of anterior lobe of pronotum faintly infuscated; scutellum dusky in the middle; outer discal cell of the membrane with a small central fuscous vitta; connexival segments near incisures with small fuscous spots; anterior and intermediate femora faintly mottled with fuscous; anterior tibia with apex and spots near middle and apex of intermediate and posterior ones fuscous; beneath with a lateral stripe on the pleura, continued along the sides of the venter.

Head somewhat more than half as long as pronotum; the preocular margin to apex of antenniferous tubercle (seen from above) about equal to postocular margin to beginning of collum; the spine at apex of antenniferous tubercle very minute; the two anterior processes (jugae) short, reaching forward to a point midway between apex of antenniferous tubercles and apex of head; porrect progenal spine quite evident; behind eyes armed with five prominent setigerous spines. Ocelli red, the space between greater than the space between one of these and the eyes. Basal segment of antenna nearly three times as long as preocular margin to apex of antenniferous tubercles; second segment over one-fourth shorter than basal, fourth segment much longer than third. Rostrum with basal segment a little longer than second and third united. Strongly dilated propleura on rim of the acetabula with several small marginal spines, the prosternal spines short, projected forward beneath the base of head. Anterior trochanters with two or three long, concolorous spines; fore femora strongly incrassate, armed below with numerous spinules, arranged in a double series towards base; anterior tibia with the usual somewhat elongate spongy fossa at apex; anterior tarsus with second and third segments fused into one; intermediate and posterior legs bristly setose; the posterior femora not reaching to apex of fifth abdominal segment. Pronotum nearly twice as long as wide with anterior lobe three-eighths longer than posterior one; the lateral margins not spinose; the dorsal surface somewhat granulose; the anterior lobe longitudinally sulcate in the middle from just behind the middle point, the disk on either side with two elongate smooth vittae, arising from a single stalk at the transverse groove; the posterior lobe broadly depressed along the middle, more deeply so in front, leaving a smooth calloused ridge on either side more evident anteriorly and evanescent posteriorly; posterior margin lightly concavely arcuate before scutellum. Elongated scutellum very slightly elevated at apex, post-scutellum with an equally elevated whitish tubercle. Apex of membrane narrowly rounded, not acute, reaching almost to middle of sixth abdominal segment. Connexivum narrowly visible from middle of first segment; the apical angles of the segments lightly prominent, but scarcely spinose; the lateral margins of the sixth segment not parallel but gradually converging posteriorly; the posterior angles (male) produced into subacute lobes with the outer lateral margins rather strongly curved and finely serrate; the sinus between semicircularly rounded with the genital segment lightly visible from above. Venter with the first four segments weakly carinate in the middle. Length, male 18 mm.; female $19\frac{1}{2}$ mm.

Type: Male, Tabernilla, Canal Zone, Panama, May 13, 1902. Paratypes: Male, same locality, June 4, 1907; females—2 same locality June 1 and 14th, 1907; 3 La Chorrera, Panama, May 10, 1912, all collected by Aug. Busck (U. S. N. M.); 1 female, Cano Saddle, Gatun Lake, Panama, May 8, 1923, coll. by R. C. Shannon (U. S. N. M.). Don Diego (100 ft.), Dept. Magdalena, Colombia; Puerto Suarez, Bolivia, 150 m. (Acc. No. 3845 Carnegie Mus.). Male, Aracataca, Magdalena, Colombia, Aug. 8, 1920 (Acad. Nat. Sci. Philadelphia).

This species is related to *mexicana* but can be readily distinguished by the absence of spines on the lateral margins of pronotum.

Ctenotrachelus elongatus n. sp.

Color dusky testaceous-cinereous; head anteriorly with a longitudinal vitta and surface behind ocelli fuscous; pronotum and corium outwardly somewhat embrowned; inner field of corium lightly and membrane more plainly mottled with fuscous irrorate with pale, a fuscous spot at apex of clavus, another on apical vein of discal cell and a somewhat elongate vitta near the center of the outer cell of membrane; basal segment of antenna with one or two abbreviated fuscous vittae; anterior and intermediate femora faintly mottled with brown with a distinct brown spot some distance from apex; the anterior and intermediate tibia, the latter only towards apex, with a longitudinal fuscous stripe; connexivum and exposed part of abdomen, posteriorly more or less infuscated, the latter with a distinct longitudinal black vitta, intermixed with irregular longitudinal pale spots on either side; pleura with a longitudinal fuscous vitta; venter with central carina entirely and lateral surface on either side mottled with fuscous, mottling arranged in two broad indefinite vittae; extreme apical angles of connexival segments black.

Head about one-half the length of the pronotum; anteocular margin to apex of antenniferous tubercles one-half the length of the postocular margin; external spine at apex of antenniferous tubercles minute; the two anterior processes (jugae) acute; before eyes, below with five or six distinct setigerous tubercles; behind eyes with four longer setigerous tubercles. Basal segment of antenna about five times as long as preocular margin to apex of antenniferous tubercles; second segment almost one-third to one-fourth longer than basal one; third segment one-third longer than fourth. Basal segment of rostrum as long as the second and third united. Pronotum with lateral margins mutic, twice as long as wide, anterior lobe three-eighths longer than posterior lobe, the former with the usual longitudinal median deep groove from just before the middle to the posterior lobe, where it is continued as a gradually widened median depression, with a broad somewhat elevated area on each side. Dilated anterior acetabula with a few spines on the margin; the black prosternal spines acutely well produced. Anterior trochanters with two or three prominent spines at apex; anterior femur moderately incrassate, less so than in *mexicanus*, armed beneath with numerous spinules; anterior tibia nearly as long as femur with an elongate, oval spongy fossa at apex; anterior tarsus with second and third segment fused; intermediate legs short, the femur shorter than anterior one; posterior femur, relatively short, apex reaching to middle of fourth abdominal segment. Elongate scutellum lightly elevated at apex (post-scutellum mutilated). Rounded apex of membrane reaching to beyond the middle of the fifth abdominal segment. Lateral margins of abdomen anteriorly subparallel, posteriorly with margins of fifth and base of sixth lightly converging, remainder of sixth nearly parallel sided; apical angles of connexival segments most lightly prominent; posterior angles of sixth extended posteriorly in two somewhat acute lobes, each a little longer than their diameter at base, their inner margins oblique to the rounded base of sinus; genital segment slightly visible from above. Venter longitudinally strongly carinate in the middle through the first three and to the middle of the fourth segment. Length 22 mm.

Type: Male, Caracas, Venezuela (Coll. of J. R. de la Torre-Bueno).

This species differs from all of the other species in the less incrassate anterior femora, relatively longer abdomen which is longer than the remainder of the body and with shorter hind femora.

(To be Continued)

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ESSAY ON THE SUBFAMILY STENOPODINAE OF THE NEW WORLD

(Continued from December, 1929)

Ctenotrachelus lobatus n. sp.

Color grayish testaceous; head, pronotum anteriorly followed by a rather wide fascia paralleling the lateral margins of both lobes and corium, faintly infuscated; the latter faintly, and the membrane mottled with pale sordid white, with a short black streak near the center of the outer cell; apical part of basal segment of antenna obscurely as well as narrow base of second segment embrowned; anterior femora faintly mottled with fuscous; anterior tibia in front with a short sub-basal and pre-median streak and the apical half infuscated. Connexivum, posterior exposed part of abdomen heavily infuscated, with a few longitudinal pale fasciae inwardly; narrow middle line on the meso- and metasternum and venter as well as a similar line running along the pleurae infuscated; sides of the venter with two or three longitudinal irregular broken fuscous fasciae, a small oval spot on each segment anteriorly midway between middle line and margins.

Head one-half as long as pronotum; the two anterior processes (jugae) are extended forward on a line with the apex of head seen below; behind eyes, below armed with five setigerous spines. Basal segment of antenna longer than in the other species described, but little shorter than head, five times as long as the preocular margin, and sparsely pilose;

second segment also pilose, one-third longer than basal one; third and fourth segments nearly equal in length. Pronotum nearly twice as long as wide; anterior lobe three-eighths longer than posterior one; lateral margins mutic; longitudinally sulcate from the middle point and continued as a gradually widened depression on the posterior lobe where it is bounded on each side by two broad longitudinal elevations, longitudinally depressed along the margins. Dilated acetabula spined along the anterior margin; prosternal spines black, well developed. Anterior trochanters with a few spines; femur less incrassate about $2\frac{1}{2}$ times wider than tibia, and more elongate than in *mexicanus*, about as long as the pronotum, armed below with numerous spinules in a single series with a double series towards base; anterior tibia shorter than femur with a short spongy fossa at apex; tarsus with the second and third segments fused into one. Scutellum elongate (mutilated). Rounded apex of the membrane reaching to just beyond the middle of the fifth segment of abdomen. Lateral margins of the abdomen nearly parallel, the apical angles of the connexival segments with a slightly prominent subacute spine; angles of the fifth more prominent; posterior angles of the sixth segment projected posteriorly in two broad rounded lobes, with a broadly rounded sinus between; the genital segment slightly visible from above. Venter with the first three segments longitudinally carinate in middle. Intermediate legs missing. Apex of posterior femur not reaching to apex of fourth abdominal segment. Length 22 mm.

Type: Male; Rio Janeiro, Brazil (Coll. of P. R. Uhler in the U. S. N. M.).

This species is most closely related to *C. elongatus*, from which it can be distinguished by the relatively longer basal segment of antenna and its pilosity, the longer and less incrassate fore femora and character of the posterior angles of the sixth abdominal segment. This answers somewhat to the description of *C. longicollis* of Walker but disagrees in several particulars.

Ctenotrachelus infuscatus n. sp.

Male. Testaceo-stramineous, heavily infuscated. Head before the eyes and behind the eyes on either side with a longitudinal testaceous fascia; anterior and posterior lobe of pronotum except for the paler longitudinal ridges of the latter, mottling of pleura, a wide longitudinal stripe below on pleura, fuscous; scutellum except for pale tubercle of post-scutellum, hemielytra except for scattered, irregular spots and broad irregular white fascia in the outer discal cell and adjoining area of membrane, infuscated; connexival segments posteriorly, a row of orbicular spots on the testaceous venter within the lateral margins and fainter maculations elsewhere, fuscous; antennae testaceous with apex of basal, base and apex of second infuscated (third and fourth segments missing). Rostrum testaceous, base, middle annulus of basal and inner base of second segment fuscous. Legs testaceous; anterior femora irregular below, intermediate and posterior pairs more faintly infuscated; anterior and intermediate tibia annulate with fuscous premedianly and apically.

Closely related to *mexicanus.* Dorsal parts not setulose but sparingly pilose. Head, from apex to anterior margin of pronotum, one third shorter than pronotum; pre-ocular margin to apex of antenniferous tubercles, a little shorter than post-ocular margin; jugae slender, parallel, not acute at apices; antennal tubercles outwardly furnished with a small setigerous spinule; behind eyes below armed with four rather long, simple setigerous spines; before eyes with a row of very small setigerous spinules; genae anteriorly acute. Basal segment of antenna very sparsely pilose, one third shorter than head from apex of antenniferous tubercles to collum; very nearly three times as long as preocular margin; second segment one fourth longer than first. Pronotum with lateral margins unarmed; not quite twice as long as wide; the narrower anterior lobe considerably longer but not twice as long as posterior lobe; the posterior lobe with a low longitudinal calloused ridge on either side of middle, rather widely separated posteriorly, the surface between rugulose. Anterior margin of propleura and rim of acetabulum with short spines; prosternal spines very small, porrect; lateral margins of prosternal grooves with a row of small black spinules. Apex of scutellum furnished with a slightly elevated, stout, semi-erect tubercle; post-scutellum with a small, yellow tubercle rounded at apex. Discal cell of corium over twice as long as wide, bounded inwardly and posteriorly by fuscous veins; faintly spotted with pale. Membrane with posterior inner margin sinuate; apex nearly acute, nearly reaching middle of sixth abdominal segment. Apical angles of connexival segments 1 to 5 acutely prominent, lateral edge between these spinulose; apical angles of sixth segment acute not attenuate; the sinus between widely rounded. Venter plainly, longitudinally carinate to middle of fifth segment. Anterior trochanters with three or four small, black spinules; incrassate fore femora scarcely setose, armed below with a row of small spinules of uneven length; spongy fossa of anterior tibia rather short. Length of male 22 mm.

Type: Male, Villa Braga, Brazil, Dec. 1919 (Acc. No. 6544 Carnegie Mus.).

This may be differentiated from *mexicanus* by its different coloration, lack of setae on the body and legs, shorter pronotum with non-spinous lateral margins and more evident carinae on posterior lobe of pronotum, etc.

Ctenotrachelus setulosus n. sp.

Color, grayish stramineous. Head sparsely sericeous and setose; somewhat less than half as long as pronotum; eyes not very strongly protruding; preocular margin to base of antenna a little shorter than postocular margin to beginning of collum; the ocelli almost twice as far apart as each is remote from eyes; spine at outer apex of antenniferous tubercles extremely small; jugae short, acute. Basal segment of antenna, sparsely setose, but little shorter than entire head; second segment one-third longer than basal; third and fourth segments subequal, together nearly as long as basal segment. Pregenal spines at base of rostrum very prominent. Through entire ventral surface of head provided with a row of setigerous spines on each side of middle; behind eyes armed with a double row of setigerous spines—five in the lower series, three or four in the upper series. Rostrum not banded with fuscous; basal segment but little shorter than second and third united. Pronotum with lateral margins armed with setigerous spines; over twice as long as wide, not constricted laterally; anterior lobe almost one-third longer than posterior one, canaliculate down the middle from before the middle point; posterior lobe longitudinally, shallowly depressed in the middle and within the lateral margins, posteriorly; anterior and humeral angles unarmed. Anterior acetabula dilated and armed with small spines along anterior margin. Anterior trochanter with a few small spines. Anterior femora long, as long as pronotum, and moderately incrassate, just over twice as wide as tibia, provided with numerous setigerous spines above and armed below with a row of numerous small spines; anterior tibia almost straight, shorter than femur, with a short, apical, spongy fossa; anterior tarsus long with second and third segments fused into one; anterior claws contiguous at base, little divaricate towards apex; intermediate femur short, this and the posterior one provided with numerous setigerous spines; apex of the latter reaching just behind middle of fourth abdominal segment; scutellum lightly elevated at apex but not furnished with a tubercle. Membrane lightly flecked with brown, with a short, fuscous fascia near the center of the outer cell; apex narrowly rounded, reaching slightly beyond the apex of the fifth abdominal segment. Lateral margins of the abdomen parallel, finely spinose serrate, ending in two somewhat acute flaring lobes, with a broad, obtuse sinus between; the margins on each side provided with three or four setigerous spines. Venter distinctly carinate through the first four segments, less distinctly so, on the fifth and sixth segment. Length of 21.5 mm.

Type: Male, Coroico, Bolivia. (Author's collection).

In this species the body and legs are more setulose than in other members of the genus; the anterior femora are relatively longer and less incrassate. As other differences are relative I have hesitated to erect a distinct genus for it.

Ctenotrachelus striatus n. sp.

Testaceous. Two narrow lines on the anterior part of head coalescing on the transverse stricture, a single longitudinal median line running from the stricture to base, sides of head before and behind eyes fuscous; pronotum with several narrow longitudinal fuscous striae forming a regular pattern with more obscure and less definite lines on posterior lobe; a broad fuscous band running from the anterior margin of the propleura to the posterior margin of metapleura; scutellum with central region, sides and apex infuscated; spine of post-scutellum pale; hemielytra infuscated; irregularly blotched with paler spots, appearing striated because of the pale veins; outer discal cell of membrane sometimes provided with a post-median orbicular black spot; membrane lightly irrorate with fuscous and obscurely pale streaked; antennae pale, basal segment apically below, second segment in the middle and at apex lightly infuscated; legs pale, anterior trochanters and extreme base of femora below, black; remainder faintly marked with fuscous; intermediate and posterior femora irregularly banded with fuscous before the apex, elsewhere somewhat mottled with fuscous; all tibia with a premedian and apical fuscous annulus.

Head about one-third shorter than pronotum; pre-ocular margin to apex of antenniferous tubercles slightly longer than post-ocular margin to beginning of collum; spine of antenniferous tubercles very small; jugae slightly divergent, acute; behind eyes below armed with three simple, black, setigerous spines followed with one or two minute ones; before eyes with a row of minute spinules; ocelli somewhat further apart than each is removed from the eyes. Basal segment of antenna one-half as long as entire head and twice as long as pre-ocular margin; second segment over one-fourth longer than first. Pronotum relatively broad, nearly one-half as wide as long; lateral margin not provided with spines or setae; posterior lobe one-third shorter than anterior one, the former with two low longitudinal dorsal carinae on each side of the middle; the inner ones more evident; anterior margin of propleura and rim of acetabula spinose; prosternal spines short, acute; margins of prosternal grooves spinulose. Scutellum with a blunt low tubercle at apex; post-scutellum armed with an anteriorly inclined sub-acute spine not as high as scutellar tubercle. Veins of corium pale; discal cell not twice as long as wide; posterior inner margin of membrane sinuate; apex not acute, reaching beyond middle of sixth abdominal segment. Apical angles of connexival segments prominently acute, the edge appearing serrate between these; apical angles of sixth segment of male produced into short triangular lobes which extend but little beyond apex of the genital segment; sinus between broadly rounded. Venter with only the first and second segments plainly longitudinally carinate in the male, first three in the female. Legs very sparsely setose; anterior trochanters with one longer and three smaller black spines; rather strongly incrassate anterior femora armed below with a row of small, irregular spines; spongy fossa of anterior tibia shorter than tarsus. Length male 21 mm. Female 25 mm.

Besides being larger and differently colored than *mexicanus* the body is not setose, pronotum is relatively longer and is unarmed along the lateral margins; pre-ocular is a little longer than post-ocular margin of head; fore femoral spines are fewer, etc.

Type: Male; Hyutanahan, Rio Purus, Brazil, Feb., 1922. Collected by S. M. Klages (Acc. No. 6963). Allotype: Nova Olinda, Rio Purus, Brazil, May 1922. Same collector (Acc. No. 6962). Paratypes: Males, Pied Saut, Oyapok R., Fr. Guiana, Dec., 1917 (Acc. No. 6111); Mana R., Fr. Guiana, May, 1917 (Acc. No. 6008). All in Carnegie Museum.

Ctenotrachelus acutus n. sp.

Male. Testaceous; head, anterior lobe of pronotum, apex of scutellum, acute apical angles of connexival segments, propleura above and lateral line on all of the pleura, exposed part of sixth abdominal segment in great part and first segment of antenna except at base heavily infuscated; apex of second segment of antenna and most of rostrum embrowned; scutellum, except outer basal angles marked with fuscous; hemielytra lightly infuscated, interspersed with small pale spots; discal cells of membrane testaceous, spotted and obscurely streaked with fuscous; venter nearly immaculate, a slender, median longitudinal fuscous line on the carina and one or two small fuscous spots on each segment between middle line and lateral margins; legs testaceous nearly immaculate, anterior and intermediate tibia in the middle and at apex faintly marked with brown.

Body and legs non-setose. Head somewhat more than half as long as thorax, about as long as anterior lobe of thorax; eyes strongly protruding; pre-ocular just one-half as long as post-ocular margin to beginning of collum; ocelli set further apart than each is removed from the eyes; behind eyes armed with four simple setigerous spines; before eyes laterally devoid of spinules or setae but beneath with several setose spinules; jugae acute, subparallel; antenna rather profusely long pilose; basal segment as long as entire head, six times as long as pre-ocular margin; second segment one-fourth longer than first and third much shorter than fourth segment; rostrum glabrous. Pronotum with lateral margins unarmed, not quite twice as long as wide; anterior more than one-third longer than posterior lobe; latter furnished with a wide, deep, longitudinal, parallel sided groove in the center, either side of which is a wide, flat, elevated ridge, depressed between this and the margins; anterior margin of propleura and rim of acetabula with minute spinules; prosternal spines short, black, acute; lateral margins of prosternal groove with a row of extremely short spinules, appearing somewhat crenulate. Scutellum merely calloused at apex; spine of post-scutellum mutilated. Discal cell of corium not quite twice as long as wide; inner apical margin of membrane slightly sinuate; apex just passes posterior margin of fifth abdominal segment, narrowly rounded. Lateral margins of abdomen nearly parallel; apical angles of connexival segments acutely prominent; posterior angles of sixth segment (male) drawn out into two long narrow processes, slightly divaricate, but little shorter than remainder of segment, narrowly rounded at apices; sinus between truncate at base. Venter longitudinally carinate through the first three segments. Anterior trochanters provided with a few small concolorous spines; moderately incrassate fore femora with a row of small black-tipped spinules between each two of which is a smaller one; anterior tibia straight with a very short spongy fossa at apex; apex of posterior femora scarcely reaching to posterior margin of fourth abdominal segment. Length male 21 mm.

Type: Male Hyutanahan, Rio Purus Brazil, Mch., 1922; collected by S. M. Klages (Acc. No. 6963) Carnegie Museum.

This species is more closely related to *elongatus* but the shorter pronotum, more protuberant eyes, prominent acute angles of connexival segments and the long attenuated posterior angles of the sixth abdominal segment will serve to distinguish it.

Key to Species of Ctenotrachelus Stål.

1. Lateral margins of pronotum provided with a row of small setigerous spines; legs setulose 2
   Lateral margins of pronotum unarmed 4
2. Pronotum over twice as long as entire head; eyes not strongly protruding; basal segment of antenna three times as long as pre-ocular margin of head; anterior femora lightly incrassate, about as long as pronotum .... **setulosus** n. sp.
   Pronotum less than twice as long as head; eyes strongly protruding; anterior femora strongly incrassate, shorter than pronotum 3
3. Basal segment of antenna twice as long as pre-ocular margin of head; pre-ocular and post-ocular margins equal; anterior lobe of pronotum one-third longer than posterior one. Length 18 mm. .... *mexicanus* Champ.
   Basal segment of antenna three times as long as pre-ocular margin of head; post-ocular margin of head longer than pre-ocular; anterior lobe of pronotum but one-sixth longer than posterior lobe. Small species, 14 mm. .... **minor** n. sp.
4. Post-ocular margin of head to collum plainly longer than pre-ocular margin to apex of antenniferous tubercles 5
   Post-ocular and pre-ocular margins of head nearly equal or the former shorter than the latter 9
5. Abdomen elongate; apex of membrane not reaching or scarcely surpassing apex of fifth abdominal segment. Larger species; 21–22 mm. 6

Abdomen shorter; apex of membrane reaching to or beyond middle of sixth abdominal segment. Smaller species; 15–16 mm. 8

6. Pronotum twice as long as wide; sixth abdominal segment ending in two acute triangular lobes, not attenuated; eyes not strongly protruding .... **elongatus** n. sp.

Pronotum not twice as long as wide; sixth abdominal segment not as above; eyes strongly protruding 7

7. Pronotum at least twice as long as head; post-ocular margin of head not twice as long pre-ocular; sixth abdominal segment ending in two broadly rounded lobes; anterior femora much longer than tibia, somewhat longer than pronotum. **lobatus** n. sp.

Pronotum evidently not twice as long as head; post-ocular twice as long as pre-ocular margin of head; sixth abdominal segment ending in two rather long, attenuated, slender lobes; anterior femora but little longer than tibia, equal to pronotum in length .... **acutus** n. sp.

8. Pronotum twice as long as head, the former over twice as long as wide; post-ocular twice as long as pre-ocular margin of head .... *macilentus* Stål

Pronotum not nearly twice as long as head, the former not twice as long as wide; post-ocular margin of head not twice as long as pre-ocular .... **shermani** n. sp.

9. Pre-ocular margin of head one-third longer than post-ocular; basal segment of antenna twice as long as pre-ocular margin of head; first two ventral abdominal segments carinate. **striatus** n. sp.

Pre- and post-ocular margins of head nearly equal; first four segments of ventral abdominal segments carinate 10

10. Head behind eyes armed with three simple spines; not spinulose before eyes; basal segment of antenna twice as long as pre-ocular margin of head; non-infuscated species. **testaceus** n. sp.

Head behind eyes armed with four simple spines; spinulose before eyes; basal segment of antenna over twice as long as pre-ocular margin of head; heavily infuscated species. **infuscatus** n. sp.

Stenopoda Laporte.

(Type *cinerea* Lap. 1832.)

Characters: Body elongate; head subequal to pronotum in length; pre-ocular much longer than post-ocular part;

eyes strongly protruding; anteriorly between antenniferous tubercles armed with two acute processes (jugae); behind eyes below armed with several simple setigerous spinules; ocelli lightly elevated; first segment of antenna as long or longer than head; rostrum strongly incrassate, basal segment shorter than second and third united; anterior angles of pronotum acute or spinose; humeral angles acute and often spinose; two median dorsal carinae posteriorly more or less elevated; prosternal spines long, acute; anterior femora not strongly incrassate, armed below with numerous spinules and setae; anterior tibia as long as femur with a long spongy fossa at apex; posterior femora in the male reaching to or surpassing the apex of abdomen; venter of abdomen carinate; apex of membrane acute.

Stål, 1859, was in error concerning absence of spongy fossa on the anterior tibia. They are very distinct in both species here enumerated. I have not been able to recognize Distant's species *scutellatus* described from Ecuador.

Stenopoda cinerea Laporte.
(= *culiciformis* Fab.).

This is smaller than the following species, measuring 20–22 mm. long. First segment of the antenna is about as long as entire head, the latter, seen from above, is twice as long as wide across the eyes; the pronotum is as long as head and somewhat wider than long; dorsal carinae of posterior lobe but little elevated; abdomen of male is not parallel sided throughout, the two margins gradually converging from apex of fourth segment, also this part of the body seen from above is less than twice as long as head and thorax together; apical spongy fossa of anterior tibia occupying about one-fourth to one-third of its length. It is quite variable in the number of setae on the head, disk and lateral margins of pronotum as well as in the length of the hairs on the femora and tibiae.

Distribution: America (Fab.); Cuba (Laporte, Stål and others); Haiti, St. Vincent, Grenada in the West Indies, Panama and southern United States (Uhler); Mexico, Guatemala and Nicaragua (Champion). Specimens at hand show a very wide distribution from New York through all of the Eastern States, Mexico, Central America, most of the West Indies and in all of the South American countries as far south as Córdoba in the Argentine Republic.

Stenopoda cana Stål.
(= *subinermis* Stål).

This is a large robust species measuring 25–27 mm. long. The elongate abdomen of the male is either parallel sided throughout or the lateral margins of the sixth segment may sometimes be somewhat converging; basal segment of antenna is usually a little longer than the head; the head and pronotum together being less than half as long as the abdomen; apical spongy fossa of anterior tibia occupying at least half of its length. It varies in the acuteness of the humeral angles of pronotum as well as in the height of the dorsal carinae of the posterior lobe although these are usually strongly elevated. If I have diagnosed Stål's *subinermis* correctly I would place it as a synonym of this species rather than of *cinerea* where it was placed by Champion. Stål in 1859 remarked that it was closely allied to *cana.*

Distribution: Brazil (Stål); Demonti, Oyapock R., Fr. Guiana (Carnegie Mus.); Kartabo, Br. Guiana (Van Duzee Coll.); Moengo, Boven Cottica R., Surinam (Cornell Coll.); Hyutanahan and Nova Olinda, also Rio Janeiro, Brazil (Carnegie Mus.); San Paulo, Brazil (my coll.); Prov. del Sara and Sta. Cruz de la Sierra, Bolivia (Carnegie Mus.); Coroico, Bolivia (my coll.).

Stenopodessa n. gen.

Closely related to and having much the general appearance of *Stenopoda cinerea* but with quite distinct structural characters. Body, antennae and legs long setose. Head shorter than pronotum; pre-ocular much longer than post-ocular margin, the latter gently rounded to collum; eyes very strongly projecting, setose; laterally behind eyes armed with several distinct, simple, setigerous spines; ocelli large and strongly elevated; antenniferous tubercles outwardly spined; jugae strongly divaricate; basal segment of antenna as long or a little longer than head, provided with a number of setose spinules, especially below; second segment densely pilose, over one-third longer than first; third one-third shorter than fourth segment; basal segment of rostrum somewhat longer than second. Pronotum including lateral spines wider than long; anterior lobe a little longer than posterior one, the latter sericeous and strongly bicarinate; lateral margins provided with setose spinules; posterior margin strongly depressed. Scutellum longer than wide with lateral margins calloused, setose; a rounded semi-erect tubercle at apex. Corium setose on some of the veins and lateral margin.

Membrane with posterior inner margin sinuate; apex acute. Apical angles of connexival segments spinose; lateral margin between these setose. Metasternum and venter strongly carinate in the middle. Legs much as in *Stenopoda;* anterior femora little incrassate, armed below with a series of small spines, setose between these; anterior tibiae without spongy fossa; anterior tarsi distinctly three segmented.

Type: **Stenopodessa piligera** n. sp.

Stenopodessa piligera n. sp.

Stramineous-testaceous, sparsely sericeous; head, pronotum, antennae and legs long pilose. Head about one-third longer than wide; eyes strongly projecting, globose, long setose; pre-ocular margin to apex of antenniferous tubercles, seen from above, two-fifths longer than post-ocular margin, the latter gradually contracted posteriorly and furnished with four or five setigerous spines; antenniferous tubercles furnished with a distinct, blunt, setigerous spine; ocelli large, strongly elevated; the two anterior processes (jugae) strongly diverging, acute at apices; lateral margins before eyes with numerous setigerous spines as well as long hairs, the latter much longer than diameter of an eye; basal segment of antenna but little longer than head, very long pilose and armed below with a row of 9–10 small setigerous tubercles; second segment almost one-third longer than basal, also long pilose; third segment much shorter than fourth; rostrum with basal segment one-third longer than second, the latter subequal to third; pronotum somewhat longer than wide with the transverse dorsal impression just before the middle; disk of anterior lobe with long setae set on short spines; longitudinally canaliculate from the middle point to the transverse stricture; anterior angles armed with a stout, oblique, acute, setigerous tooth; lateral margins with 4–5 nearly cylindrical spines each tipped with a long seta, the one before the transverse stricture much stouter; posterior lobe sericeous, sparsely setose, the two longitudinal carinae posteriorly strongly elevated into acute tubercles or spines; between these with a less distinct ridge which does not reach posterior margin; lateral margin and sides of propleura with a few setigerous spines; posterior angles armed with a stout spine, tipped with several setae; posterior margin before the scutellum depressed, strongly concave; prosternal spine long, armed below with small setigerous spinules; scutellum sericeous, much longer than wide, lateral margins calloused, long setose, with a rounded reflexed tubercle at apex;

hemielytra faintly mottled with fuscous, somewhat sericeous and sparsely setose, the margins anteriorly setose; the discal cell of corium with the inner half infuscated; outer discal cell of the membrane inwardly with a fuscous stria followed by a similar streak outwardly; acute apex of the membrane nearly reaching apex of abdomen; lateral margin of abdomen with a short spine at the apical angles of segments 1–5, between each of which are several spinules tipped with setae; venter of the abdomen sparsely pilose with a broad longitudinal irregular fuscous band on either side; carinate down the middle; sixth segment with lateral margins nearly parallel, gently converging posteriorly to the obtusely rounded apical angles; posterior margin setose; lateral lobes scarcely extended, broadly truncate in the middle; the character of the legs is much the same as in *Stenopoda* but long setose; anterior femora armed beneath with 9–10 short spines with several setose spinules between these; intermediate femora with a series of small setigerous spines beneath; anterior tarsus with terminal segment equal to first two united. Length male 24 mm. Diameter of pronotum 5 mm.

Type: Male, Matto Grosso, Brazil, Dec. 6–10, 1919 (Cornell Univ.). Paratypes: Five males, Prov. del Sara, Bolivia, Nov. 1913; coll. by Steinbach (Acc. No. 5068, Carnegie Mus.).

Seridentus Osborn 1904

(Type *denticulatus* Osborn)

Characters: Body elongate. Head, including collum, somewhat shorter than pronotum and little longer than wide; eyes strongly projecting, set midway between base and apex; ocelli somewhat elevated; antenniferous tubercles very short and apically spined; the two anterior processes (jugae) prominent, somewhat elevated; tylus vertical; postocular part of head gradually narrowed from eyes to collum and armed below with several simple spines. Basal segment of antenna longer than head, with the second segment a little longer than basal. Genae anteriorly produced in a short obtuse, porrect spine at base of rostrum; the latter with basal segment a little shorter than the second and third together. Pronotum decidedly longer than wide, gradually widened posteriorly from the base, scarcely constricted laterally; disk of anterior lobe longitudinally sulcate from behind the middle point; anterior angles not spinose; humeral angles obtusely rounded, not at all prominent. Scutellum much longer than wide, provided with a stout tubercle at apex; postscutellum armed with a smaller tubercle. Corium with a large pentagonal discal cell. Inner margin of membrane gently sinuate before obtusely rounded apex. The connexival margins of abdomen slightly visible from above, nearly parallel to each other; the apical angles of all abdominal segments somewhat prominent with apical angles of the sixth ending in two flaring lobes between which is a broad shallow obtuse sinus. Anterior coxae somewhat elongate; trochanters not spinose; femora lightly incrassate, armed below with a few small spines, very finely denticulate between these; tibia as long as femur with a short spongy fossa at apex; anterior tarsi with three distinct segments, claws widely divaricate. Venter with the first two segments longitudinally carinate.

Seridentus is closely related to *Schumannia* Champion from which it differs chiefly as follows: relatively broader and shorter head, unarmed before the eyes below; relatively longer basal segment of antenna, about as long as second segment and long pilose, third and fourth segment not capillaceous; ocelli more elevated; shorter basal segment of rostrum; shorter legs with anterior femora less spinose beneath, trochanters unarmed; second and third segment of anterior tarsus not fused.

Seridentus denticulatus Osborn

Sparsely pilose. Head except anteriorly, pronotum for the most part, scutellum, clavus except for three pale spots, corium and membrane in part irregularly, extreme apical angles of connexival segments, sixth dorsal segment of abdomen in great part, central median ventral stripe and irrorations on each side of abdomen, a longitudinal stripe on the pleura, fuscous. Central area of the corium and inner area of the membrane whitish spotted with brown. Pleura, venter, legs and antennae stramineous, the latter with apex of basal and all of second segment embrowned.

Head about one-third shorter than pronotum and two-sevenths longer than width across eyes; gradually contracted behind eyes; eyes strongly projecting, globose and sparsely, finely pilose. Somewhat elevated ocelli large, a little further apart than each is removed from eyes. Two anterior processes (jugae) almost erect, united at base, not very acute at apices. Antenniferous tubercles outwardly armed with a short stout spine. Below before eyes with a few minute setigerous tubercles; behind eyes with four long setigerous spines. Basal segment of antenna a little longer than head, densely long pilose; second segment embrowned, almost as long as basal and also densely long pilose; third segment almost one-third as long as second and fully one-third longer than apical one; the last two not much more slender than the second. Basal segment of rostrum a little shorter than the second and third segments united. Anterior acetabula dilated and armed with a few spines on anterior margin; prosternal spines black, porrect, well developed. Anterior trochanters almost or quite devoid of spines; anterior femur moderately incrassate, almost two and one-half times as wide as tibia, below armed with five or six short spines as an inner series, and with an outer row of numerous very minute spinules; anterior tibia straight, not shorter than femur, provided at apex with a short oval spongy fossa; anterior tarsus long; first and second segment fuscous, together a little shorter than apical segment; posterior femora not extended beyond apex of fourth abdominal segment. Pronotum considerably longer than wide; with anterior sparsely pilose lobe a little longer than posterior one; canaliculate from just behind the middle, continued on the anterior part of posterior lobe as a broad shallow depression; transversely depressed behind anterior margin, the anterior angles unarmed; the lateral margins with a row of setigerous tubercles or spines; disk of posterior lobe on either side provided with small tubercles; humeral angles rounded; posterior margin lightly concave before base of scutellum. Scutellum with a stout, long erect tubercle at apex; post-scutellum with a much smaller tubercle. Discal cell of corium large. Membrane somewhat sinuated before rounded apex which reaches just past apex of fifth segment of abdomen. Lateral margins fairly parallel to each other, finely serrate and shortly setose along the edge. Connexivum narrowly visible from beginning of the second segment, the apical angles of the segments ending in short acute spines, angles of the fourth and fifth more produced; posterior lateral angles produced into two broad, flaring lobes, acute at apex, with a broad, shallowly arcuate sinus between these. Ventral segments plainly carinate in the middle, the third more faintly so; each segment midway between median line and lateral margin with a distinct sunken black glandular oval spot. Length of male 21 mm.

Records:—Demerara, V, 6, 1901. Coll. by R. G. Crew. Paratype in the collection of E. P. Van Duzee which he has kindly loaned to me for study.

Seridentus consimilis n. sp.

Male. Stramineous; posterior margin of pronotum on either side of middle, narrow central line of the middle, as well as the apical and post-scutellar spine, maculations of connexivum and dorsal aspect of sixth abdominal segment fuscous; hemielytra sordid white much irrorate with pale brown; an elongate brown spot in the outer discal cell of the membrane contiguous to the outer vein; the membrane in part white; antennae sordid stramineous, basal segment suffused with brown, second segment with a median and apical fuscous band, last two segments infuscated; prosternal spine, prosternum, meso- and metasternum with a continuous, broad, longitudinal, fuscous stripe; venter irregularly, heavily irrorate with fuscous; anterior coxae, trochanters below and base of femora fuscous, remainder of anterior femora irregularly and faintly spotted with fuscous; all tibia with a premedian and apical fuscous band.

Very closely related to *S. denticulatus.* Head behind eyes more swollen, evidently wider than before eyes; below, behind eyes armed with three simple setigerous spines; the very acute jugae nearly porrect, separated at base; antenniferous tubercles outwardly armed with a small black spine. Basal segment of antenna as long as head, measured from apex of antenniferous tubercles to beginning of collum, provided with a few fine setae and short hairs, not long pilose within; second segment almost twice as long as basal, provided with short hairs scarcely longer than diameter of the segment; third and fourth segments nearly equal, together as long as basal, finely shortly pilose, anterior trochanters armed with one or two small spinules; fore femora setose, anteriorly projecting beyond the apex of basal segment of antenna; armed below with a row of 6–7 small spines, between which are several small setigerous spinules; anterior tibia slightly curved, shortly setose outwardly, shortly pilose within; anterior tarsi with the two basal segments black, these together nearly one-half as long as terminal one. Pronotum over twice as long as head from apex of antenniferous tubercles to beginning of collum, just over one-third longer than wide; finely pilose; lateral margins not provided with a row of small spines as in *denticulatus;* prosternal spine long, very acute, porrect, projecting anteriorly beyond posterior margin of eyes; rim of acetabulum spinose; lateral margins of the prosternal groove provided with a row of small black spinules. Scutellum armed at apex with a rather long, blunt, semi-erect spine; post-scutellum with a prominent, erect, blunt spine or tubercle which is constricted basally, nearly as long as scutellar spine. Apical angles of all connexival segments 1 to 5 provided with acute nearly erect, black spines as in *denticulatus;* lateral margins between these with a row of black, setigerous spinules directed obliquely backwards; sixth abdominal segment much as in *denticulatus* except that the lateral posterior angles are not quite so flaring. Length: Male 20 mm.

Type: Male; Pied Oyapok River, French Guiana, Dec. 1917. Collected by S. M. Klages (Acc. No. 6111 Carnegie Museum).

This species can be differentiated from *denticulatus* by its paler color, more swollen post-ocular region of the head, different character of the jugae, shorter basal segment of antenna as well as different pilosity, longer pronotum with mutic lateral margins, longer prosternal spines and post-scutellar tubercle, etc.

Achillas Bueno 1914.
(Type *bicaudatus* Bueno.)

Head over one-half as long as pronotum; eyes strongly protruding; pre-ocular shorter than post-ocular margin; the latter not parallel sided but gently rounded, converging posteriorly; spined laterally and dorsally; ocelli large; antenniferous tubercles, externally spined; jugae well developed, porrect; genae anteriorly provided with a porrect spine at base of rostrum. Basal segment of antenna a little shorter than entire head; the second segment somewhat longer than first; third and fourth subequal. Basal segment of rostrum shorter than second and third united. Pronotum a little longer than wide, rather deeply constricted laterally and dorsally; the two lobes nearly equal in length; lateral margins spinose; the central disk of anterior lobe longitudinally canaliculate behind the anterior transverse depression; anterior angles with a small tubercle externally; humeral angles rounded. Anterior acetabula dilated and spined along the edge; trochanters with a few spines; anterior femora lightly incrassate, long pilose and spined above, with a row of stout spines below; anterior tibia as long as femur, with an oval spongy fossa at apex; anterior tarsus with three distinct segments. Scutellum with a stout tubercle at apex; postscutellum also with a tubercle. Hemielytra with a large discal cell; apex of membrane reaching middle of 6th abdominal segment. Lateral margins of abdomen near the posterior angles of segments 2–5 provided with spined foliaceous lobes; apical angles of the sixth produced in two long, very acute processes with a broad sinus between. First three segments of the venter longitudinally carinate.

Achillas bicaudatus Bueno.

Color stramineous; head dorsally lightly embrowned; basal segment of antenna with a central band, the second segment with a slight basal, median and apical band, pronotum through central disk, base of femora below and apex of clavus fuscous; hemielytra including outer fourth of membrane heavily, the remainder of membrane much more lightly, mottled with fuscous. Head dorsally provided with short spines, these becoming longer posteriorly; pre-ocular margin to base of antenna short, less than one-half the length of eye, apically with a distinct oblique spine externally on the antenniferous tubercles; eyes strongly bulging, finely setose; ocelli rather large, twice as far apart as each from the eyes; post-ocular margins converging from the eyes to collum; behind eyes latero-ventrally with two or three simple spines; ventrally with four pairs of setigerous spines, posterior pair the longest; pre-genal tooth at base of rostrum obtuse. Basal segment of antenna long pilose, externally with five or six short spines; almost as long as head to beginning of collum; second segment long pilose, a little longer than first; third and fourth subequal, pilose. Basal segment of rostrum decidedly shorter than second and third united. Pronotum with a marginal row of unequal, irregular spines; deeply transversely constricted across the middle; anterior angles externally with a small tubercle; strongly depressed behind anterior margin, with a sharply defined canal running from this to the transverse stricture; disk on either side of canal with a series of small spines, area between these and margin smooth; posterior lobe longitudinally, shallowly, broadly depressed in the middle; the somewhat elevated ridges on either side, provided with small spines; strongly depressed within the humeral angles which are obtusely rounded. Prosternal processes well developed, acute, somewhat deflexed and provided with a tooth or spine near base. Anterior femora pilose armed below with six or seven stout spines and above with a crowded series of unequal spines; tibia as long as femur with a distinct oval spongy fossa at apex. Scutellum with short setigerous spines on the disk and apex armed with a stout blunt tubercle; postscutellum with a short, acute, black, erect tubercle. Lateral margin of abdomen provided with four foliaceous lobes, toothed along their margins, between these two or three short spines on the margins of segments; sixth segment ending in two long, attenuated, acute processes, reflexed; distinctly setose-spined along their inner margins; a broad rounded sinus between these, with the genital segment slightly visible from above. Length 25 mm.

Described from the type: Tumatumari, Rio Potaro, Brit. Guiana in the Coll. of J. R. de la Torre-Bueno.

As remarked by Mr. Bueno this genus is closely related to *Seridentus* of Osborn from which it differs particularly in the character of the abdominal margins.

Apronius Stål 1865.

(Type *rapax* Stål.)

Body somewhat elongate; head longer than wide; somewhat or decidedly shorter than pronotum; pre-genal spines at base of rostrum lacking; eyes strongly projecting, glabrous; lateral margins behind eyes not parallel but gradually converging towards collum; ventro-laterally behind eyes sometimes armed with a few very small scattered setigerous spines; ventrally between the eyes armed with two to four pairs of setigerous spines; ocelli very little elevated; jugae short; antenna with basal segment shorter than head; basal segment of rostrum shorter than the two apical ones taken together, first and second nearly equal. Pronotum nearly as wide as long (a little longer than wide in *octonotatus*); shallowly, transversely depressed through the middle; humeral angles acute. Scutellum longer than wide, with slender porrect apex. Membrane acute or subacute at apex which reaches nearly to end of abdomen. Connexival margins of abdomen lightly expanded. Anterior trochanters spined; anterior femora moderately incrassate armed with a series of small spines; anterior tibia with elongate spongy fossa at apex; anterior tarsi composed of three distinct segments. Venter strongly carinate through the middle.

Apronius is somewhat related to *Oncocephalus.*

Apronius rapax Stål

Color flavous, in part rather heavily infuscated. Head fuscous, in well marked specimens with two longitudinal pale stripes anteriorly on either side of middle running to the transverse stricture; behind each eye with a diagonal pale stripe running to collum; basal segment of antenna infuscated, often paler through the middle; pronotum more or less infuscated but pale before the posterior margin; scutellum laterally and apically pale; hemielytra infuscated mottled with pale, veins of corium and membrane pale; a small black spot on the corium opposite apex of scutellum, often missing, also one in the outer discal cell of membrane; a wide continuous band on the pleura and faint mottling of venter fuscous; legs flavous, femora mottled with fuscous, anterior tibia with three and intermediate with two fuscous bands.

Head one-fifth shorter than pronotum; pre-ocular margin to apex of antenniferous tubercles subequal to post-ocular; eyes strongly projecting, dorsally equal in width to inter-ocular space; behind eyes armed with several small irregular setigerous tubercles; ventrally between the eyes with two pairs of prominent setigerous spines, sometimes followed by a pair of minute spines. Basal segment of antenna very nearly three times as long as pre-ocular margin to apex of antenniferous tubercles; second segment over twice as long as first; third and fourth subequal. Basal segment of rostrum a little longer than second. Pronotum a little wider than long; posterior lobe distinctly rugulose and with two median carinae more evident anteriorly, disappearing just before posterior margin; lateral margin before transverse stricture provided with a more or less evident tubercle; humeral angles acute, somewhat projecting. Scutellum with a rather slender, horizontal process at apex. Membrane acute at apex. Anterior femora armed with a row of small spines between which are short setae. Spongy fossa of anterior tibia a little longer than tarsus. Length, male 17 mm.; female 20 mm.

Distribution: Minas Geraes, Brazil (Stål); Napo R., Peru and Manaos, Brazil (Fracker and Bruner); Rio Janeiro and Chapada, Brazil (Carnegie Mus.); Rio Dagua, Colombia and Canal Zone (U. S. N. M.).

Apronius flavidus n. sp.

Color yellow-testaceous. Head longitudinally through the center and laterally before and behind the eyes infuscated; basal segment of antenna very lightly embrowned; pronotum transversely behind anterior margin, middle line of anterior lobe and pleura lightly infuscated; hemielytra very lightly and obscurely mottled with fuscous; corium with a small fuscous spot opposite apex of scutellum; membrane concolorous with a small spot in the center of the outer discal cell; venter mottled with fuscous on either side of middle; femora faintly mottled with fuscous; anterior and intermediate tibia with three bands.

Head much shorter than pronotum; pre- and post-ocular margins equally long; eyes strongly projecting, with the inter-ocular space much wider than diameter of an eye, seen from above; behind eyes armed with several small setigerous tubercles; ventrally between eyes with two pairs of prominent setigerous spines. Basal segment of antenna about three times as long as pre-ocular margin to apex of antenniferous tubercles; second segment a little over one-fourth longer than first; third segment nearly twice as long as fourth. Basal segment of rostrum subequal to second. Pronotum a little wider than long; posterior lobe covered with little asperities, not rugulose, scarcely at all bicarinate as it is in *rapax;* humeral angles prominent, acute. Scutellum with apical horizontal process short. Apex of membrane narrowly rounded or sometimes subacute. Legs as in *rapax.* Length male 18 mm.; female 21 mm.

Type: Male and allotype, Rio Janeiro, Brazil. Paratypes: 2 males and 3 females, same locality as type (U. S. N. M.); 4 males and 3 females same locality as above (Acc. 2966 Carnegie Mus.).

This species is so closely related to *rapax* that there is very little in Stål's description to guide one in deciding which of the two is his species. The species here described as new is quite different in coloration; the interocular space of head is wider, the relative lengths of the antennal segments is quite different and the surface of posterior lobe is not so evidently bicarinate and is unwrinkled.

Apronius octonotatus Champion 1898.

Well characterized by Champion in the Biol. Cent. Amer. Rhynch. II, p. 186, 1898, and figured on Tab. XI, fig. 22, 22a. This species is considerably smaller than the two preceding and differently marked. The head beneath has four pairs in place of two pairs of setigerous spines, the first and fourth pairs being much shorter. The pronotum is also less depressed across the middle and decidedly longer than wide.

Records: Bugaba, Volcan de Chiriqui, Panama (Champion); 4 specimens from Panama and one from Brit. Guiana (U. S. N. M.); one female Demerara Brit. Guiana, coll. by R. J. Crew in the collection of E. P. Van Duzee.

Kodormus n. gen.

Body rather broad and somewhat depressed. Head granulose, a little shorter than pronotum with pre-ocular part twice as long as post-ocular; the former much the narrowest; the latter rather abruptly rounded, contracted toward base and armed below behind eyes with two stout ramose spines or processes; ventrally before eyes with two sub-acute tubercles and another pair before base; antenniferous tubercles armed with a stout spine or tubercle at apex; anteriorly between bases of tubercles armed with two divaricate sub-acute tubercles (jugae), tylus strongly depressed. Eyes very strongly protruding, slightly transverse and extending somewhat on the lower surface of head. Ocelli large, strongly elevated. Basal segment of antenna short, second segment much longer than first. Genae not anteriorly produced in a porrect spine at base of rostrum; the latter strongly incrassate with basal segment not extended beyond anterior margin of eyes, decidedly shorter than second and third taken together. Pronotum with anterior angles prominent, shortly spinose; granulate, wider than long, obtusely constricted just before the middle; anterior lobe longitudinally sulcate behind the middle point; lateral margin with a row of small setose tubercles, disk on either side of the middle provided with a blunt tubercle; humeral angles rather acutely prominent. Prosternal spines short. Scutellum slightly longer than wide with a short, erect tubercle at apex; post-scutellum also with a small tubercle anteriorly. Discal cell of corium longer than wide and with the transverse apical vein not distinct. Rounded apex of the membrane reaching well past the middle of the sixth abdominal segment of abdomen. Abdomen flaring; apical angles of the abdominal segments 1–3 prominent, the fourth segment widest, strongly angulated behind middle. Legs rather long, anterior coxae and trochanters armed with a few stout tubercles; anterior femora rather strongly incrassate, spinulose beneath; anterior tibia curved about as long as the femur and without a spongy fossa at apex; all tibiae compressed; apex of posterior femora not quite reaching apex of abdomen. Venter strongly carinate longitudinally to apex of the fifth segment.

This genus has no close affinity to any other genus of the sub-family but appears to come close to *Rhyparoclopius* Stål in the broader character of the body. Type **bruneosus** n. sp.

Kodormus bruneosus n. sp.

Color castaneous brown; with antennae, anterior tibiae and venter paler; a sordid white orbicular spot near the center of the outer apical cell of the membrane; anterior femora, intermediate and posterior legs and connexivum infuscated. Body in part distinctly granulose, non-pilose. Head with collum about one-third longer than width across eyes and but little shorter than pronotum; surface covered with fine granules tipped with minute recumbent hairs. Eyes finely, sparsely pilose, very strongly projecting, their diameter about one fourth less than inter-ocular space. Pre-ocular part of head one third longer than post-ocular including collum and considerably narrower; from eyes abruptly, roundly contracted and armed ventro-laterally with two rather large setigerous ramose spines or processes, placed one above the other; base with a small setigerous tubercle on each side of the middle. Ocelli large, strongly elevated, sulcate between, about as far apart as each is removed from the eyes. Antenniferous tubercles very short and outwardly armed with short setigerous tubercles at their apices. Anteriorly, between and before these are two acute, divaricate processes (jugae), fused at their bases; the tylus much deflexed and extended before these. Ventrally, before eyes with a distinct setigerous tubercle on either side of the middle, preceded by several smaller ones, another pair before base. Genae not anteriorly produced in a process at base of rostrum. Basal segment of antenna somewhat incrassate, short, extending a little beyond apex of head, about twice as long as the pre-ocular margin, second segment densely long pilose nearly three times as long as first; third and fourth very slender, pilose, subequal. Rostrum strongly incrassate, apex of basal segment extending as far as anterior margin of eyes, subequal to second segment, the third about one-half the length of second. Pronotum about one fourth wider than long, not laterally constricted; anterior lobe a little shorter than posterior one; disk of anterior lobe somewhat convex, with irregular smooth areas interspersed with distinct granules particularly in front; longitudinally deeply sulcate from the middle point; central disk on each side with a somewhat elevated granulated tubercle; anterior margin depressed, constricted laterally; anterior angles truncate and armed with a short subacute spine outwardly; lateral margins with a single series of small, pale tubercles (granules) beset with short recurved hairs. Posterior lobe somewhat granulose, anteriorly with a short, deep longitudinal sulcation, continued from anterior lobe; longitudinal ridges on each side of this not strongly elevated; humeral angles acutely prominent; posterior margin before base of scutellum gently concave; prosternal spines, short porrect, above which is another short marginal spine. Scutellum strongly elevated, apex armed with a small, erect, acute tubercle; post-scutellum depressed and anteriorly armed with a small, round, pale tubercle. Hemielytra with the corium entirely coriaceous, obsoletely granulose and provided with scattered, recumbent, fine hairs; discal cell twice as long as wide, the inner and outer veins strongly curved, the apical vein obsolete or missing. Bluntly rounded apex of the membrane reaching well past middle of sixth abdominal segment. Legs somewhat elongate finely hispid; anterior trochanters armed with a few stout, acute tubercles; anterior femora rather strongly incrassate, armed beneath with two series of widely separated short, acute tubercles; anterior tibia as long as the femur, gently curved throughout, somewhat compressed, without a spongy fossa at apex; the posterior femora and tibiae of equal length, apex of the former reaching nearly to middle of sixth abdominal segment; the tibiae compressed and gently curved; third segment of the posterior tarsus about as long as the first and second together; the tarsal claws widely divaricate. Abdomen with connexivum strongly expanded, gradually expanded to obtuse angles of fourth segment, thence strongly narrowed to the apex of sixth segment which is narrowly truncate; apical angles of first, second and third segment somewhat prominent. The venter irrorate with fuscous, longitudinally strongly carinate to apex of the fifth segment; surface with scattered minute recumbent hairs. Length 21 mm.

Type: Male, Cabima, Panama, May 26, 1911, coll. by A. Busck (U. S. N. M.); Paratype: Female, Tumatumari, Brit. Guiana, July 12, 1921 (A. M. N. H.); Male, Bartica, Brit. Guiana (J. R. T.-Bueno).

Rhyparoclopius Stål 1868

(Type *desiccatus* A. and S.)

"Antennae short, first segment shorter than preocular part of head; head cylindrical or subcylindrical; legs rather short, posterior femora not reaching to apex of abdomen. Body and legs destitute of granules and spines; anterior trochanters and femora only beneath armed with spinules; body somewhat elongate; head and thorax almost equally long, the former cylindrical, beneath unarmed, apex devoid of a spine at base of rostrum; preocular part almost three times longer than postocular, the latter a little wider than former; eyes mediocre, somewhat transverse, scarcely sinuate posteriorly; antennae short, inserted towards apex of head, first and second segments of rostrum nearly equally long, the former somewhat shorter than preocular part of head; thorax equally long as wide, anteriorly sinuate narrowed, in the middle very lightly, obtusely constricted; posterior lobe six angled, apex of lateral angles rounded; hemielytra reaching apex of abdomen, apex of membrane terminating in a less distinct angle; abdomen beyond middle sensibly ampliated, lateral margin at apex of segments obtusely prominent; legs mediocre, anterior femora somewhat incrassate. Anterior tibia destitute of spongy fossa. Allied to genus *Podormus.*" Stål.

I have two specimens before me of a new species which with considerable doubt I have placed in this genus. But not having been able to see specimens of either *desiccatus* A. and S. or *annulirostris* Stål I have quoted the above translated diagnosis from Stål, rather than base the characters on the new species.

Rhyparoclopius dubius n. sp.

Body and legs densely tomentose pilose, devoid of spinules and granules. Sordid grayish-brown; anterior and intermediate tibia indistinctly annulated with fuscous before base, in the middle and towards apex. Head almost as long as thorax, cylindrical, pre-ocular part not quite three times as long as post-ocular part; the latter a little wider than former; gula and post-ocular region below unarmed with spines; eyes moderately projecting, not transverse; ocelli small, not elevated, a little further apart than remote from eyes; antenniferous tubercles with a minute porrect spine, externally; two anterior processes (jugae) rather thick, subacute extending almost one-sixth way on the basal segment of antennae; no porrect spine or process at base of rostrum. Basal segment of antenna rather strongly incrassate, lightly curved, as long as preocular margin of head to base of antenna; second segment one third longer than basal one; third and fourth segments very slender with the latter much longer than former. Rostrum with basal segment much shorter than pre-ocular part of head, much shorter than second and third united, subequal to second. Pronotum as long as wide, transversely obtusely constricted just behind the middle; anterior lobe somewhat convex, posteriorly longitudinally canaliculate; the disk on either side with several irregular tomentose ridges, with narrow smooth areas between; the anterior angles armed with a small oblique tubercle externally; disk of posterior lobe anteriorly with two low ridges, diverging posteriorly and gradually disappearing; strongly depressed within the humeral angles which are distinctly elevated but unarmed; posterior margin strongly declivous, sinuate before scutellum. Prosternum anteriorly somewhat dilated; the prosternal spines, stout, acute, porrect. Anterior trochanters with a few black spines beneath; anterior femora rather strongly incrassate, with a row of 10–12 small acute spinules below, with equally long, curved setae between these; anterior tibia a little shorter than femur, without a spongy fossa at apex; anterior tarsus short, with second and third segments fused into one; posterior coxae further apart than they are remote from lateral margins of the pleura; posterior femora not reaching to apex of abdomen. Scutellum somewhat longer than wide, depressed in the middle at base; rather suddenly contracted at middle, ending in a rather slender subacute apex. Hemielytra with some of the veins infuscated, claval vein posteriorly and neighboring vein of the discal cell pale yellow; discal cell twice as long as wide; the membrane sordid, somewhat paler than corium, with a broken, oblique, fuscous fascia, a portion in the outer middle part of the outer discal cell, the remainder just outside of the limiting external vein; just anterior to this a sordid white fascia; the rounded apex almost reaching the apex of abdomen. Abdomen considerably wider than the hemielytra; apical angles of the connexival segments 1–3 obtusely prominent, 4–5 more strongly obtusely angled; the sixth ending in two short rounded lobes with a broad rounded sinus between these. The venter longitudinally canaliculate through segments 1 to 5. Length of male 12.5 mm.; female 13.5 mm.

Type: Male, Santarem, Brazil (Coll. of H. H. Smith in the A. M. N. H.). Allotype, same data; paratype male, Taperina, Brazil (Acc. No. 2966 Carnegie Mus.).

This species is much smaller than *dessiccatus* Amy. et Serv. which measures 22 mm. and of *annulirostris* Stål which is 17 mm. long.

Diaditus Stål 1859

(Type *semicolon* Stål)

Body oblong. Head cylindrical, but little if any shorter than pronotum; pre-ocular somewhat longer than post-ocular margin; unarmed before or behind eyes below; base of head, dorsally with a subacute, posteriorly directed tubercle on each side of the middle; antenniferous tubercles furnished externally with a minute spine; anteriorly between bases of antennae with two elongate porrect processes (jugae) well extended beyond apices of antenniferous tubercles. Ocelli strongly elevated. Eyes rather strongly protruding. Basal segment of antenna shorter than head. Basal segment of rostrum nearly equal to the second and third united. Legs slender, rather long; anterior femora scarcely incrassate, unarmed beneath; posterior pair not reaching to apex of abdomen; anterior tibia without a spongy fossa at apex. Abdomen a little wider than hemielytra.

Diaditus pictipes Champion

This is the smallest species of the genus thus far known. The head from apices of jugae is considerably shorter than pronotum, at least in the male; the pre-ocular margin to apex of antenniferous tubercles not twice as long as post-ocular margin; jugae one-seventh shorter than pre-ocular margin; the antennae are relatively short and very shortly pilose; the basal segment less than half the length of the head to tip of jugae; second segment about one-fourth longer than basal; third and fourth united nearly as long as second. The pronotum is a little wider than long with the humeral angles obtusely rounded. Ventral segments of the abdomen non-carinate in the female, obtusely and lightly carinate in the male. Length 8–8.5 mm.

Distribution: Mexico, Guatemala (Champion); Los Mochis, Sinaloa, Mexico (Coll. E. P. Van Duzee); Tapachula, Mex. (U. S. N. M.); Edinburg and Brownsville, Tex. (J. R. T.-B.); Alvin and Brownsville, Tex.; Morales, Guat. (author's coll.).

Diaditus hirticornis Champion

Male; head from apex of jugae as long as pronotum; pre-ocular margin to apex of antenniferous tubercles over twice as long as the post-ocular margin; jugae nearly as long as the pre-ocular margin, rather slender and acute; antennae relatively longer than in the preceding species; basal segment of antennae about one third shorter than length of head from apex of jugae; second segment about one third longer than basal and clothed with long, nearly erect hairs; second and third segments united much shorter than second. Pronotum is evidently wider than long with the humeral angles acute and somewhat reflexed. Ventral segments of the abdomen sharply keeled. Anterior tarsi distinctly three segmented. Length 9 mm.

Distribution: Panama (Champion); Canal Zone, Panama and Trinidad (U. S. N. M.); Zanderij, Boven, Para Dist., Dutch Guiana (Cornell.).

Diaditus semicolon Stål

Female; Head to tip of jugae a little longer than pronotum; pre-ocular margin to apex of antenniferous tubercles two-fifths longer than post-ocular margin; jugae longer than pre-ocular margin, stout, and contiguous at apices; basal segment of antenna less than half as long as head to apices of jugae; second segment very shortly and sparsely pilose one-third longer than basal; three and four united are as long as basal, much shorter than second. Pronotum very nearly as wide as long with humeral angles subacute. Anterior tarsi with 2 and 3 segments united into one; hind tibia shortly pilose. Length 12 mm.

Distribution: Montevideo, Uruguay (Stål), Argentine Rep. (Berg). Corumba, Matto Grosso, Brazil (Author's coll.); Bolivia (M. C. Z.); Bahia, Santarem, and Taperina, Brazil; Prov. del Sara and Sta. Cruz de la Sierra Bolivia (Carnegie Mus.); Para and Igaripe, Brazil (U. S. N. M.).

Diaditus pilosicornis Bergroth

If I am not mistaken in the identity of this species it is scarcely distinguished from *annulipes*. Before me are three male specimens from Demerara, British Guiana, type locality of Dr. Bergroth's species.

The head is evidently granulose and somewhat longer than the pronotum; as compared with *annulipes* the eyes are less projecting; antennae, rostrum and the two anterior processes (jugae) are quite similar the latter variable in relation to each other, gently curved towards apex where they are in contact or nearly so; the tibia are provided with three fuscous bands in place of two as in *annulipes;* the anterior angles of the pronotum are provided with a more pronounced acute spine; the posterior tibia are provided with very short setae, less than half as long as width of the tibia. Markings and other characters the same as in *annulipes*. Size 11.5–12 mm.

Distribution: Demerara (Bergroth). Mackenzie R., Demerara, Brit. Guiana (Cornell); Santarem, Brazil, and Sta. Cruz de la Sierra, Bolivia (Carnegie Mus.).

Diaditus annulipes Berg

Male: Head is distinctly granulose, one-third longer than diameter across eyes; the pre-ocular margin to apex of antenniferous tubercles not twice as long as post-ocular margin; the two anterior processes (jugae) a little longer than pre-ocular margin; basal segment of antenna almost twice as long as pre-ocular margin, second segment long pilose, almost twice as long as basal; third and fourth together but little shorter than basal segment. Pronotum a little longer than head but little wider than long; anterior angles armed with a distinct acute spine; posterior angles acute, somewhat reflexed; disk of posterior lobe with four distinct longitudinal carinae, the outer ones less obvious; hemielytra with the usual markings; edge of each connexival segment with two slight fuscous markings; abdomen with the venter longitudinally distinctly carinate; apical margin of the genital segment lightly sinuate in the middle; all tibia with base, apex and premedian band infuscated; the posterior tibia rather densely pilose, the hairs over twice as long as diameter of the tibia. Length 11.5–12 mm.

Distribution: Chacabuco, Argentine (Berg); Las Vazques, Tucuman, Argentina and Sapucay, Paraguay (U. S. N. M.); Cordoba, Argentina (M. C. Z.).

Diaditus latulus n. sp.

Color grayish testaceous; area between ocelli, rostrum, several obscure longitudinal fascia on the pronotum located on the sunken areas, two narrow longitudinal striae on the scutellum; mottling of the clavus, a streak on the disk of the corium opposite the commissure, the discal cell, outer cell of the membrane with a small prebasal followed by a broad elongate fascia, sinuate in front, edge of the connexivum with two fascia on each segment, pleura and venter laterally, irregularly, coxae and trochanter in part, femora for the most part and tibiae each with three bands, fuscous.

Finely granulose. Head of the male about one-fourth, of the female one-third longer than wide; pre-ocular margin to apex of antenniferous tubercles somewhat shorter than length of an eye, and nearly two-fifths longer than post-ocular margin; two anterior processes (jugae) rather short and stout, contiguous except at apices; extending about half their length beyond the apex of the antenniferous tubercles; antennae relatively short; basal segment less than half as long as the pre-ocular margin; second segment in the male twice as long, in the male one-fifth longer than the basal one; third and fourth segments together as long as basal; long pilose in the male, shortly setose in the female; rostrum with the basal segment a little longer than second and third united; pronotum of male one-fifth longer than wide; anterior angles armed with a short acute spine; posterior angles of the male somewhat acute, obtusely rounded in the female; anterior lobe shorter than the distinctly granulose posterior lobe and distinctly separated by five depressions, the central one deepest; the longitudinal dorsal granulose carinae not as distinct as in the other species described; scutellum anteriorly in the middle very lightly sulcate; either side of the middle with deeper and nearly parallel sulci; apex of membrane in male reaching to end of abdomen; apical margin of genital segment rather deeply incised in the middle with a broad somewhat truncated lobe on each side; venter sharply carinate. Pile of posterior tibia a little longer than the diameter of the tibia. Length of male 12 mm.; female 13 mm.

Type: Male; San Juan, Argentine Rep. Coll. by C. S. Read (Cornell); Allotype same data. Paratype: male same data (head and thorax missing).

This species differs from *annulipes* by being broader with a shorter head and antennae as well as in the character of the two anterior processes.

Key to Species of Diaditus

1. Second segment of antenna not long pilose or setose; second and third anterior tarsal segments almost fused into one 2

   Second segment of antenna finely long pilose; second and third anterior tarsal segments distinct 4

2. Jugae very short, not reaching one-third way on basal segment of antenna; head short, not nearly twice as long as wide and decidedly shorter than pronotum; second segment of antenna but little longer than first; pronotum much wider than long; anterior femora reaching beyond apices of jugae .... **latulus** n. sp.

   Jugae longer, nearly reaching to middle point of basal segment of antenna; head nearly or quite twice as long as wide and but little shorter than pronotum; second segment of antenna about one-third longer than first; pronotum but little wider than long; anterior femora not extending to apices of jugae 3

3. Size small, 8 to 8.5 mm.; pronotum a little wider than long; jugae evidently shorter than pre-ocular margin of head, not reaching to middle point of basal segment of antenna .... ♀ *pictipes* Champ.

   Size larger, 12 mm.; jugae about as long as pre-ocular margin of head, reaching to middle point of basal segment of antenna; pronotum as long as wide .... ♀ *semicolon* Stål

4. Second segment of antenna one-third longer than first; jugae slender, divergent; posterior lobe of pronotum with two divergent carinae .... ♂ *hirticornis* Champ.

   Second segment of antenna at least twice as long as first; jugae rarely divergent; posterior lobe of pronotum with two dorsal carinae on each side of the middle, the outer ones less distinct 5

5. Entire head (dorsal view) from apices of jugae as long as pronotum and more nearly twice as long as wide; hind tibia with short, fine, appressed setae .... ♂ *pilosicornis* Berg.

   Entire head evidently shorter than pronotum, nearly one-third as wide as long; hind tibia with rather long, fine, oblique setae .... ♂ *annulipes* Berg.

Narvesus Stål 1859

(Type *N. carolinensis* Stål)

Head about as long as pronotum; eyes strongly projecting, globose; pre-ocular margin longer than post-ocular margin; anteriorly between antenniferous tubercles furnished with two short acute processes (jugae); post-ocular margin below armed with several obtuse spinules; ocelli strongly elevated; basal segment of antenna shorter than head. Rostrum not strongly incrassate; basal segment but little shorter than second; eyes closely approximate below. Pronotum nearly as wide as long; anterior angles spinose; humeral angles rather acute; lateral margins just before the shallow transverse depression furnished with a small tubercle. Anterior femur scarcely incrassate; armed below with a few small spines; posterior femora in the male surpassing the apex of abdomen. Abdomen a little wider than hemielytra. Venter strongly, acutely keeled. Closely related to *Onocephalus*.

Narvesus carolinensis Stål

Distribution: Carolina (Stål); St. Vincent and Grenada Is., W. Ind. (Uhler); Yucatan, Mexico (Champion). Specimens before me from Eden, Nicaragua (Acad. N. S. Phil.), Cuba and nearly all of the southern states from Virginia south to Florida and west to Missouri and Arizona. Specimens from the latter state are paler than more eastern forms.

Narvesus minor n. sp.

Pale grayish-cinereous; two longitudinal striae on the head anteriorly, area between ocelli and extending to base of head, sides of head before and behind eyes, rostrum, depressions of pronotum obscurely, lateral margin of propleura, scutellum either side of the middle line, a slight streak in the middle of the clavus, an obscure elongate triangular fascia on the disk of corium, the discal cell, an elongate subtriangular fascia sinuate anteriorly on the outer cell of the membrane preceded on the anterior margin by a small orbicular spot, connexival margins of abdomen with two elongate streaks on each segment sometimes merged, meso- and metapleura with two irregular streaks, venter with a line on each side of the middle, mottling of fore femora, apices of the intermediate and posterior pairs, fore and intermediate tibiae with bases, apices and middle, base and apex of the posterior tibia infuscated.

Male: Very closely related to *N. carolinensis* but somewhat smaller with the head relatively a little longer in relation to its diameter; the pre-ocular margin to apex of antenniferous tubercles relatively longer in relation to the post-ocular margin; all of the segments of the antenna rather long pilose, the first and second segments pale; the anterior and intermediate tibia not trifasciate with fuscous, the posterior tibia with shorter pile than in *carolinensis*.

Female: Coloration much the same except the connexivum and exposed part of the abdomen is infuscated. The pre-ocular margin of the head relatively longer than in the male; the eyes less bulging; the second segment of the antenna not long pilose; apices of posterior femora not reaching apex of abdomen; anterior femora somewhat more incrassate than in the male. Length, male, 11.5; female, 14 mm.

Type: Male, Moengo, Boven Cottica R., Dutch Guiana, May 14, 1927; Allotype: Same data, May 13; Paratypes: 13 males and 1 female, same data as type; 2 males Tumatumari, Potaro R., Brit. Guiana, June, 1927; 1 female Corumba, Matto Grosso, Brazil, Dec., 1919 (Cornell Univ.); male, Tumatumari, British Guiana (A. M. N. H.); Puerto Suarez, Bolivia (Acc. No. 3845 Carnegie Mus.).

Key to Species of Narvesus

Anterior and intermediate tibia trifasciate with fuscous; posterior tibiae shortly pilose; pronotum scarcely wider than long. Smaller species from South Amer.; male 11.5 mm. .... **minor** n. sp.

Anterior and intermediate tibia not trifasciate with fuscous; posterior tibiae long pilose; pronotum decidedly wider than long. Larger species from U. S., Mex., C. Amer. and W. Ind.; male 14 mm. .... *carolinensis* Stål

Oncocephalus Klug 1830

(Type *notatus* Klug)

Body rather elongate-oval; eyes of male large, of female smaller, set rather close together beneath; several rather distinct setigerous tubercles behind eyes; ocelli somewhat elevated; antennae and tibiae particularly in the male often long pilose; jugae somewhat produced and lightly elevated; apex of genae not produced; basal segment of rostrum shorter than the two apical ones united; anterior femora distinctly, strongly incrassate, and distinctly spinose beneath; hemielytra of the female sometimes abbreviated.

This genus is very closely related to *Narvesus* from which it may readily be distinguished by its strongly incrassate, spinose anterior femora. *O. ventralis* Walker, described from San Domingo, I have not been able to distinguish.

Oncocephalus geniculatus Stål

Male: Cinereous-gray. Head decidedly shorter than pronotum, the latter about one-sixth wider than long; the eyes below are about as far apart as the diameter of the second segment of the rostrum at the middle point; first segment of antenna nearly glabrous, 1.5 mm. long, second segment densely long pilose, 3.5 mm. long, the third and fourth segments each about one-half the length of basal; pronotum a little wider than long with a distinct lateral tubercle before the transverse impression; anterior angles obliquely truncate with a short subacute spine outwardly; humeral angles acute; posterior tibia with a little longer and denser pile than in *apiculatus*. Length 14–15 mm.

Distinguishable from *apiculatus* by its slightly more robust form; wider spacing between the eyes below; relatively longer first and second segments of the antenna.

Distribution: Texas (Stål); Lakehurst, N. J., and St. Petersburg, Fla. (Coll. J. R. T.-B.); Plummers Is., Md. (U. S. N. M.); Knoxville, Tenn., Douglas and McPherson Cos., Kans. (My coll.).

Oncocephalus apiculatus Reuter

Male: Very closely related to the preceding but somewhat more slender. The eyes are set closer together below, the space between not more than half as wide as the diameter of the second rostral segment at the middle; the first two segments of the antenna are relatively shorter, the basal about one mm. long, the second nearly 3 mm. Length 13 mm.

Distribution: Brownsville, Tex. (Coll. of J. R. T.-B. and author).

Oncocephalus nubilus Van Duzee

Male: This is a robust pale species from the S. W. part of the United States readily distinguished by the absence of the usual fuscous patches in the discal cell of the corium and membrane; pilosity of the basal segment of the antenna as well as its greater length; absence of lateral tubercle of the pronotum as well as the less acute humeral angles; more spines on the anterior femora (10–11); longer pile on the posterior tibia within, nearly glabrous outwardly; the eyes below almost as far apart as the diameter of the second rostral segment at the middle and provided posteriorly with a distinct seta on each side. Length 17–18 mm.

Ditribution: Cochise Co., Ariz. (Van Duzee); Douglas, Ariz., Jemez Springs, N. Mex., Brownsville, Tex., Hamilton Co., Kans.; Monterey, N. Mex. (J. R. T.-B.); Phoenix, Welton, Paloma, Ariz.; Deming, N. Mex.; Brownsville, Tex. (Author's coll.); Gomez Palacio, and Tlahualilo, Mex. (U. S. N. M.).

Oncocephalus erectus Van Duzee

Male: This species is also without the usual fuscous patches in the discal cell of corium and membrane, but it is smaller and more heavily infuscated than the preceding. It has a short head with the eyes below nearly in contact; basal segment of antenna as long as head, only about one-half as long as second, densely long pilose, the pile of second being four or five times as long as diameter of antenna; the pronotum is much longer than wide; anterior angles rounded, posterior angles acute; lateral margins without a tubercle before the sinus; anterior femora with 8–9 spinules; connexivum reddish. Length 14 mm.

Distribution: Angeles Bay, Lower Calif. (E. P. Van Duzee); Purissima, Lower Calif. (U. S. N. M.).

Oncocephalus validispinis Reuter

Male: A rather slender species heavily infuscated between the longitudinal pale striae of the pronotum. Preocular margin to apex of antenniferous tubercles nearly twice as long as post-ocular margin, the latter rounded; basal segment of antenna glabrous, sordid testaceous, paler at base, but little more than twice as long as pre-ocular margin; second segment just a little over twice as long as basal, densely short pilose; pile a little longer than diameter of segment; third a little shorter than second segment; these united equal to basal; space between the eyes below somewhat narrower than the diameter of the second segment of rostrum at the middle point; pronotum decidedly wider than long; lateral margin before the transverse impression provided with a distinct tubercle; anterior angles with a distinct acute spine outwardly; posterior angles armed with acute somewhat reflexed spine; posterior lobe with eight longitudinal fuscous stripes, without elevated ridges; scutellum fuscous, with a medium pale stripe at least posteriorly; corium suffused with fuscous between the elevated pale veins; discal cell provided with a large black spot; inner apical margin of the membrane sinuate, its apex obtusely rounded; outer cell provided with a broad elongate black fascia, sinuate before and acutely tapering behind; connexival segments of the abdomen infuscated at their apical angles; sixth abdominal segment posteriorly ending in two broadly rounded lobes extending slightly beyond the almost truncated median lobe; the posterior margin of the latter almost two-thirds as wide as the lateral lobes; anterior femora heavily infuscated below and provided with 10–11 small spinules, anterior tibia with three fuscous rings; intermediate and posterior femora widely embrowned at apex; posterior tibia with base and apex very narrowly infuscated, densely setose, the setae nearly twice as long as the diameter of the tibia. Length 12–13 mm.

In the female the second antennal segment has extremely short setae, much shorter than diameter of segment; the connexivum heavily infuscated; setae of the posterior tibia shorter, no longer than diameter of the tibia; apex of membrane narrowly rounded; apex of abdomen acutely attenuated. Length 16–17 mm.

Distribution: Bahia, Brazil (Reuter); Igarapé Assú, Brazil, and Bartica, Br. Guiana (J. R. T.-B.); Georgetown, Br. Guiana, and Rurrenabaque, Beni, Bolivia (U. S. N. M.); Moengo, Boven Cottica R., Surinam; Tumatumari, Potaro R., and Mackenzie, Demerara R., Br. Guinea (M. C. Z.); Tumatumari, Br. Guiana (A. M. N. H.); Coroico, Bolivia, and Iquitos, Peru (Author's coll.); Rio Janeiro, Santarem, and Hyutanahan, Brazil; Upper Mazaruni R., Br. Guiana; Puerto Suarez and Prov. del Sara, Bolivia (Carnegie Mus.).

Oncocephalus antipodus Reuter

Male: A little more robust than *validispinis* with the pronotum more heavily infuscated and the pale striae more indistinct or usually less plainly indicated. Pre-ocular margins of head twice as long as the post-ocular margins, the latter nearly parallel to each other; basal segment of antennae very sparsely shortly setose inwardly; pale at base: nearly one-third longer than the pre-ocular margin; second segment much over twice as long as basal, rather densely pilose, pile nearly twice as long as diameter of the segment; space between the eyes below nearly as wide as the diameter of the second segment of the rostrum at middle point; pronotum very nearly as wide as long; lateral margin before the transverse impression with a distinct tubercle; anterior angles obliquely truncate, scarcely armed; posterior angles acute, reflexed; posterior lobe more strongly infuscated with the paler striae less evident than in *validispinis;* scutellum fuscous with the apex pale; corium not infuscated between the veins, concolorous; discal cell of the corium and outer cell of the membrane furnished with a fuscous spot similar to those in *validispinis;* each segment of the connexivum furnished with two fuscous spots, one near the middle and the other at apex; the sinus at the end of the sixth segment narrower than *validispinis;* anterior femora armed with 8–9 spinules between each two of which is a very minute setigerous spinule; anterior tibia with three fuscous rings; intermediate and posterior femora frequently with a median as well as an apical fuscous band; posterior tibia with basal, apical and obscure prebasal bands, densely setose, the setae a little longer than the diameter of the tibia; apex of membrane broadly rounded, not at all sinuated before this. Length 14–15 mm.

Female: The connexivum infuscated with a pale spot behind the middle and at the apex of each segment; abdomen posteriorly not so attenuated as in *validispinis.*

Distribution: Ecuador (Reuter); Tabernilla, Canal Zone, Panama and Posorja, Ecuador (U. S. N. M.); Guayaquil, Ecuador (Cornell); Puertó Suarez, Bolivia (Acc. No. 3845 Carnegie Mus.).

KEY TO SPECIES OF ONCOCEPHALUS

1. Pronotum without a lateral tubercle; discal cell of corium and outer cell of the membrane devoid of black patches; basal segment of antenna of male pilose 2

   Pronotum provided with a lateral tubercle; discal cell of corium and outer cell of membrane with black patches 3

2. Head, pronotum and hemielytra except laterally, black; second segment of antenna about twice as long as basal one; eyes almost in contact below; pronotum much wider than long, strongly transversely impressed near the middle. *erectus* Van D.

   Head, pronotum and hemielytra smudged with fuscous through the middle; second segment of the antenna about one-third longer than basal one; eyes below about as far apart as the diameter of the second rostral segment at middle point; pronotum about as wide as long, weakly impressed dorsally; anterior and posterior angles not spinose .... *nubilus* Van D.

3. Post-ocular part of head nearly parallel sided; basal segment of antenna five-twelfths longer than pre-ocular margin; second segment a little over twice as long as basal one; pronotum almost as wide as long, rather deeply transversely impressed behind the middle; anterior angles truncate, not spinose; anterior femora armed with about eight small spines between which are one or two minute setigerous spinules; posterior femora with wide apical and preapical fuscous bands; posterior tibia rather densely setose, setae towards apex twice as long as diameter of tibia .... *antipodus* Reut.

   Post-ocular part of head contracted or rounded; pronotum more evidently wider than long, less strongly impressed; anterior angles spinose 4

4. Body more slender; pronotum with distinct, definite, continuous, pale stripes; posterior femora with only the apex infuscated; posterior tibia with base and apex very narrowly infuscated; basal segment of antenna about one-half as long as second; anterior femora with 10–11 small spines with a minute setigerous spinule between these .... *validispinis* Reut.

   Body less slender; pronotum infuscated but without regular longitudinal, continuous pale stripes; posterior femora with broad apical and preapical fuscous bands; posterior tibia with narrow basal, prebasal and apical fuscous bands; second segment of the antenna much over twice as long as basal one; anterior femora with 9–10 small spines 5

5. Second segment of antenna about two and one-half times longer than basal one, the latter over twice as long as the pre-ocular margin to apex of antenniferous tubercles; posterior tibia densely long pilose, pile $1\frac{1}{2}$–2 times as long as diameter of the tibia. Grayish cinereous .... *geniculatus* Stål

Second segment of the antenna nearly three times as long as the basal one; the later two-fifths longer than the pre-ocular margin of head; posterior tibia densely short pilose, pile not much longer than the diameter of the tibia. Color more stramineous .... *apiculatus* Reut.

Zylobus n. gen.

Head longer than pronotum; pre-ocular much longer and more slender than post-ocular portion; the lateral margins of the latter gradually converging posteriorly, armed below with a prominent ramose spine; eyes very strongly projecting, transverse, pilose; ocelli large, strongly elevated; antenniferous tubercles armed externally with a small setigerous spine; the anterior processes (jugae) short with tylus produced between them; basal segment of antenna slightly incrassate, shorter than pre-ocular part of head; second segment much longer; third and fourth segments short; rostrum moderately incrassate, with basal segment much shorter than second and third together, but longer than second; genae not anteriorly produced in a spine. Pronotum including humeral spines wider than long; lateral margins and disk of anterior lobe provided with conspicuous setigerous tubercles; rather strongly constricted just before the middle; anterior margin depressed; anterior angles truncate with a small spine externally; posterior lobe furnished with two distinct longitudinal ridges; humeral angles acutely spinose; all of the femora rather slender, tuberculate, the anterior pair scarcely incrassate; anterior tibia a little longer than femur, without a spongy fossa at apex; intermediate femur a little longer than anterior one; posterior femora not extending to apex of abdomen. Prosternal spines very short. Scutellum but little longer than wide, armed with a stout spine at apex. Hemielytra provided in the center with two discal cells a supernumerary cell anterior to the normal apical cell; rounded apex of membrane very nearly reaching apex of abdomen. Connexival margins of abdomen somewhat expanded, with a prominent triangular subacute lobe at the posterior angles of segments one to six. Venter longitudinally carinate in the middle.

This genus not related to any of Stål's genera of Stenopodinae seems to be most closely related to *Ocrioëssa* Bergroth. Distinct peculiarities of the genus are the slender anterior femora and the presence of two discal cells in the corium. Type **lobulatus** n. sp.

Z. lobulatus n. sp.

Color brownish-cinereous; head, anterior lobe of pronotum in great part, fuscous; basal segment of antenna, basal segment of rostrum, femora and tibiae heavily mottled with fuscous; hemielytra somewhat mottled and the connexival segments banded with fuscous. Sternum and venter ferrugineous, the latter with some pale yellow spots laterally. Head granulose, one-sixth longer than pronotum, nearly twice as long as width across eyes, which are strongly bulging, a little wider than the interocular space; the pre-ocular portion one-third longer than the post-ocular, which is gradually contracted posteriorly to beginning of the collum with margins finely tuberculate; central disk dorsally before eyes with a tubercle-like elevation armed with small setigerous tubercles; ocelli large, somewhat elevated, almost as far apart as they are remote from eyes; pre-ocular margins to base of antenna parallel, as long as eyes; antenniferous tubercles armed externally with a small setigerous spine; two anterior processes (jugae) short, widely divaricate, tylus visible between these; ventro-laterally behind eyes armed with a single large biramose spine. Basal segment of antenna not much incrassate, sparsely setose, gently curved, nearly twice as long as pre-ocular margin to base of antenna; second segment much more profusely pilose, three-fifths longer than basal; third and fourth segments slender, nearly equal in length. Rostrum not strongly incrassate, remote from head; basal segment straight, a little longer than second which in turn is a little longer than third; second and third gradually becoming more slender to a very acute apex. Pronotum across humeral spines almost one-third wider than long, lateral margins with a row of conspicuous bulbous setigerous tubercles; laterally and transversely constricted just before the middle; the anterior angles broadly truncate, armed externally with a short, oblique spine; disk of anterior lobe on either side of the longitudinal groove provided with several setigerous tubercles; surface between these smooth; posterior lobe distinctly granulate; with a distinctly elevated longitudinal ridge on either side of the middle, diverging posteriorly; humeral angles provided with an acute somewhat reflexed spine. Propleura somewhat inflated, with very short porrect prosternal spines. Anterior coxal cavities placed some distance behind anterior margin of prosternum; legs setose; anterior trochanters unarmed; anterior femora scarcely at all incrassate, sparsely covered above and below with short rounded setose spines and with appressed scale like hairs; anterior tibia a little longer than femur, setose, without spongy fossa at apex; tarsi of three segments with the first and second together nearly as long as third; intermediate femur and tibia a little longer than anterior ones, the former with similar spines as the other femora; apex of posterior femora reaching beyond apex of fourth abdominal segment. Scutellum strongly elevated above the surface of the hemielytra and armed with a short, stout, erect, spine at apex. Hemielytra with anterior lateral margins finely spinose; with two discal cells, the anterior one opposite the apex of the clavus is triangular in shape, followed by a slightly larger six-angled cell. Membrane rounded at apex, with a black fascia in the outer cell near the outer vein. Connexival margins of abdomen strongly expanded beyond the margins of the hemielytra, each posterior lateral angles of the segments extended in a prominent triangular subacute lobe, margins between these with one or two small blunt spines; posterior margin of the sixth segment broadly rounded between the two posterior lateral lobes. Venter with segment 1–5 strongly carinate in the center; surface on either side of this with several series of small pale tubercles. Length of male 16 mm.

Type: Male; Cabima, Panama, May 28, 1911; coll. by Aug. Busck (U. S. N. M.). Paratypes: Males, Cabima, Panama, May 21, 1911; Salidero, Ecuador (U. S. N. M.).

Genus *Ocrioëssa* Bergroth

(Type *lobuliventris* Bergroth)

Ann. Mus. Nat. Hung. XVI, 312, 1918.

Head shorter than pronotum. Eyes strongly projecting, shortly setose; pre-ocular part of head narrower and longer than post-ocular; between antenniferous tubercles armed with two anteriorly inclined processes (jugae); ocelli strongly elevated; behind eyes ventro-laterally armed with two or three simple setigerous spines; gular region with two or three pairs of setigerous spines; genae produced anteriorly in short acute processes. Basal segment of antenna much longer than the pre-ocular margin to apex of antenniferous tubercles; second segment much longer than basal; third and fourth capillaceous. Basal segment of rostrum not extending posteriorly as far as anterior margin of eyes, subequal to second segment. Pronotum longer than wide; strongly transversely constricted near the middle; anterior angles armed with acute oblique spines; humeral angles armed with long, reflexed spines; central disk of anterior lobe armed with two erect spines or tubercles; lateral margins a little before the constriction armed with a semi-erect spine or tubercle; pronotal spines long and acute; posterior margin before scutellum concavely arcuate. Apex of scutellum armed with a long erect spine; post-scutellum with a small spine. Corium with two discal cells; anterior one triangular; posterior one six angled. Membrane about reaching to apex of abdomen; apex somewhat acuminate. Connexival margins somewhat expanded; apical angles of segments 1 to 5 ending in triangular reflexed lobes; apical angles of sixth segment ending in two acute posteriorly directed lobes. Venter longitudinally carinate through segments 1 to 5. Legs long. Anterior femora rather strongly incrassate, armed below with numerous irregularly arranged spines; anterior trochanters armed with spines; anterior tibia as long as femur, lightly curved, furnished with a short spongy fossa at apex (Bergroth in error); intermediate femora and tibia much longer than anterior ones; posterior femora and tibiae much longer than intermediate; apex of femur reaching at least to apex of abdomen.

Ocrioëssa lobuliventris Bergroth

Head testaceous variegated with fuscous; pronotum ochraceous with a median longitudinal fuscous stripe gradually widening posteriorly and broader lateral stripes somewhat broken and irregular on the anterior lobe; scutellum fuscous with lateral carinae and spine ochraceous; clavus ochraceous with a fuscous streak, wide in front, acuminate posteriorly, extending beyond apex of scutellum; membraneous areas of corium more or less infuscated, with the longitudinal veins conspicuously pale, sometimes mottled with fuscous. Membrane ochraceous mottled with fuscous, an elongate fuscous stripe in the outer cell and often with a sordid white stripe in each cell. Connexivum and venter ochraceous much variegated with fuscous. Legs testaceous variegated with fuscous. Head seen from above not quite twice as long as wide and a little shorter than pronotum;

eyes strongly projecting, seen from above, not transverse; pre-ocular but a trifle longer than post-ocular margin; the former nearly parallel sided, the latter evenly rounded from eyes to collum and armed below with two or three small setigerous spines; setigerous spines of antenniferous tubercles minute; inter-ocular space above considerably wider than an eye; diameter of gular space a little wider than base of second rostral segment; this space before and between eyes with a pair of setigerous spines; anterior processes (jugae) united at base, lightly divergent apically and inclined anteriorly; strongly elevated ocelli set a trifle closer together than their distance from the eyes; genae anteriorly produced in a spine. Basal segment of antenna pale, infuscated at base and apex, nearly four times as long as pre-ocular margin of head and profusely pilose below; second segment pale with base, apex and middle region fuscous, one-third longer than first and profusely pilose; fourth segment but little longer than third. Rostrum pale with apices of first and second and all of third segment fuscous. Pronotum is one-sixth longer than wide (excluding humeral spines); a pronounced transverse dorsal stricture just behind the middle; oblique spines of the anterior angles quite long and acute; two long erect spines in central disk of anterior lobe; lateral spine a little before the stricture somewhat shorter; anterior face of posterior lobe strongly declivous and furnished with two median carinae lightly diverging posteriorly; humeral angles armed with long nearly erect spines. Scutellum with lateral margins calloused, a long erect spine at apex; spine of post-scutellum small. Connexivum expanded; each apical angle of segments 1 to 5 ending in acute triangular lobes; posterior angles of sixth segment drawn out into two acute triangular lobes with a wide shallow sinus between these. Anterior trochanters armed with several prominent spines; incrassate fore femora with numerous small variably sized irregularly arranged spines; anterior tibia lightly curved; apical spongy fossa much shorter than tarsus; intermediate and posterior legs long and slender. Length, male 17.6 mm.

Distribution: French Guiana (Bergroth); Capero, Trinidad (U. S. N. M.).

Ocrioëssa boliviensis n. sp.

Very similar in appearance and markings as the preceding species. It differs in the following respects: diameter of the gula much wider, being about twice as wide as the diameter of base of second rostral segment and over one-half the diameter of an eye; the setose spines of that region being smaller and more numerous; anterior gular spines less acute; entire head is more roughly granulose; the antennae are shorter and not long pilose; basal segment of antenna about twice as long as the pre-ocular margin; second segment not twice as long as basal; third and fourth segments subequal; transverse stricture of pronotum across the middle, the ridges of the anterior lobe more granular; anterior face of posterior lobe less declivous; the carinae more evident and wider apart; discal spines of anterior lobe are situated before the middle and reduced to tubercles; lateral spines before the stricture are also reduced to tubercles, scarcely evident; the humeral angles are not slenderly spinose but drawn out into acuminate somewhat reflexed processes; spines of the fore femora are smaller and fewer, regularly arranged in a single row; apices of posterior femora do not surpass apex of abdomen. Length male 16 mm.

Type: Male, Prov. del Sara, Bolivia, Nov. 1913 (Acc. No. 5068 Carnegie Mus.). Paratype: Male, St. Cruz de la Sierra, Bolivia (450 M.), Nov. 1910 (Acc. No. 4550 Carnegie Mus.). Both collected by Steinbach.

Genera and Species of Stenopodinae

(Genera and species not seen by me marked by *)

Pnirontis Stål.
- **subinermis** n. sp.
- languida Stål.
- **acuminata** n. sp.
- **inobtrusa** n. sp.
- **brevispina** n. sp.
- brimleyi Blatchley.
- scorpionia Berg.
- **selecta** n. sp.
- **similis** n. sp.
- **granulosa** n. sp.
- serripes Fab.
- modesta Banks.
- tabida Stål.
- **elongata** n. sp.
- **grisea** n. sp.
- incerta Reuter.
- edentula Berg.
- infirma Stål.
- scutellaris Stål.
- pallescens Stål.*
- stali Mayr.*
- spinimana Champ.*
- filiformis Walker.*

Rutuba Bueno.
- perpugnax Bueno.

Pygolampis Germar.
- pectoralis Say.
- spurca Stål.
- **atrolineata** n. sp.

Gnathobleda Stål.
  litigiosa Stål.
  fraudulenta Stål.
Pnohirmus Stål.
  violentus Stål.
  spinifer Stål.
  whymperi Distant.*
Ctenotrachelus Stål.
  macilentus Stål.
  shermani n. sp.
  mexicanus Champion.
  minor n. sp.
  testaceus n. sp.
  elongatus n. sp.
  lobatus n. sp.
  infuscatus n. sp.
  setulosus n. sp.
  striatus n. sp.
  acutus n. sp.
  longicollis Walker.*
Seridentus Osborn.
  denticulatus Osborn.
  consimilis n. sp.
Achillas Bueno.
  bicaudatus Bueno.
Stenopoda Laporte.
  cinerea Laporte.
  cana Stål.
  scutellata Distant.*
Stenopodessa n. gen.
  piligera n. sp.
Apronius Stål.
  rapax Stål.
  flavidus n. sp.
  octonotatus Champion.
Kodormus n. gen.
  bruneosus n. sp.
Rhyparoclopius Stål.
  annulirostris Stål.*
  dessiccatus Am. et Serv.*
  dubius n. sp.
Nitornus Stål.*
  lobulatus Stål.*
  fuliginosus Distant.*
Podormus Stål.
  granulatus Stål.*
Diaditus Stål.
  pictipes Champion.
  hirticornis Champion.
  semicolon Stål.
  pilosicornis Bergroth.
  annulipes Berg.
  latulus n. sp.
Narvesus Stål.
  carolinensis Stål.
  minor n. sp.
Oncocephalus Klug.
  geniculatus Stål.
  apiculatus Reuter.
  nubilus Van Duzee.
  erectus Van Duzee.
  validispinis Reuter.
  antipodus Reuter.
Zylobus n. gen.
  lobulatus n. sp.
Ocrioëssa Bergroth.
  lobuliventris Bergroth.
  boliviensis n. sp.
? Stenopoda hyalinipennis Walker. (Unplaced.)

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Valid genera and species in Roman type; new genera and species in **bold face** type; synonyms in *italics;* † indicates animals other than insects; * indicates plants.